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APPENDIX I

AIRPORT SURFACE DETECTION EQUIPMENT ASDE-3 RADAR SET

PRELIMINARY SPECIFICATION

TSC/PTG-0012R

FEBRUARY, 1973

U.S. DEPARTMENT OF TRANSPORTATION

Transportation Systems Center

55 Broadway

Cambridge, Massachusetts 02142

ABSTRACT

This specification establishes the performance, design, development and test requirements for the Airport Surface Detection Equipment, the ASDE-3 Radar Set, intended as a replacement for the currently FAA-commissioned ASDE-2. It provides improvements in the areas of reliability, performance in heavy rain, and in the quality of the display. In addition, it is suitable for future incorporation into an Airport Ground Traffic Control System which may include multiple radars, digital data processing and command and control features.

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1.0 SCOPE

1.1 This specification establishes the performance, design, development and test requirements for the Airport Surface Detection Equipment (ASDE-3) Radar Set.

2.0 APPLICABLE DOCUMENTS

2.1 Government documents. The following documents form a part of this specification to the extent specified herein. Other documents, which are referenced within the documents listed below, shall also be treated as a part of this specification to the extent that the listed documents are specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

SPECIFICATIONS

Federal

	FAA A/C 70/7460-1	Obstruction Marking and Lighting
16 Oct 69	FAA-E-163b Amendment 2 Spec Change 3	Rack, Cabinet and Open Frame Types
13 Dec 68	FAA-D-638h Amendment 1	Instruction Books, Electronic Equipment
15 Sept 67	FAA-G-1375 Issue No. 3	Spare Parts - Peculiar For Electronic, Electrical & Mechanical Equipments
25 Feb 72	FAA-G-2100/1b Amendment 1	Electronic Equipment, General Requirements. Part 1, Basic Requirements for all Equipments
19 June 68	FAA-G-2100/2a	Requirements For Equipment Employing Electronic Tubes
19 June 68	FAA-G-2100/3a	Requirements For Equipment Employing Semiconductor Devices
5 Feb 69	FAA-G-2100/4b	Requirements For Equipment Employing Printed Wiring Techniques
24 Mar 69	FAA-G-2100/5	Requirements For Equipment Employing Microelectronic Devices
To be issued	TSC/PTG-0012D	ASDE-3 Digital Data Processing Subsystem

Military

29 Mar 68	MIL-H-46855 Amendment 1	Human Engineering Requirements for Military Systems, Equipment and Facilities

Other Government Activity

None

STANDARDS

Federal

6 Oct 67	FAA-STD-002 Amendment 1	Engineering Drawings

Military

10 May 72	MIL-STD-202D Change 2	Test Methods For Electronic and Electrical Component Parts
1 Dec 71	MIL-STD-454C Change 2	Standard General Requirements for Electronic Equipment
9 Feb 71	MIL-STD-461A Change 4	Electromagnetic Interference Characteristics, Requirements for Equipment
9 Feb 71	MIL-STD-462(USAF) Change 3	Electromagnetic Interference Characteristics, Measurement of
9 Apr 68	MIL-STD-471 Change 1	Maintainability Demonstration
18 May 72	MIL-STD-490 Change 2	Specification Practices
10 Mar 70	MIL-STD-721B Notice 1	Definitions of Effectiveness Terms For Reliability, Maintainability, Human Factors, and Safety
15 May 63	MIL-STD-756A	Reliability Prediction
15 July 69	MIL-STD-781B Notice 1	Reliability Tests Exponential Distribution
28 Mar 69	MIL-STD-785A	Requirements for Reliability Program

15 June 67	MIL-STD-810B	Environmental Test Methods
20 Nov 69	MIL-STD-883 Notice 2	Test Methods and Procedures for Microelectronics

Other Government Activity

24 Jan 69	AC NO: 00-27	U.S. National Standard For The IFF Mark X (SIF) Air Traffic Control Radar Beacon System Characteristics (ATCRBS)

DRAWINGS

None

OTHER PUBLICATIONS

Manuals

		Manual of Rules and Regulations, Office of Telecommunication Policy, White House, Washington, D. C. 20500

Regulations

12 May 72	AFR-80-14	Test and Evaluation

Handbooks

24 May 66	MIL-HDBK-472	Maintainability Prediction

Bulletins

None

Notebooks

Sept 67	RADC-TR-67-108 (AD 821640)	RADC Reliability Notebook (Volume II)

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring agency or as directed by the contracting officer.

2.2 Non-Government documents. The following documents form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

SPECIFICATIONS

None

STANDARDS

None

DRAWINGS

None

OTHER PUBLICATIONS

Radio Regulations by General Secretariat of the International Telecommunication Union, Geneva, Switzerland, 1968, revised 1972.

3.0 REQUIREMENTS

3.1 Item definition. The equipment described by this specification is a high resolution ground mapping Radar Set which shall provide the Local and Ground Controllers in the Control Tower a clear, accurate and bright presentation of airport runways, taxiways and aprons; and of any stationary or moving aircraft or vehicles on these surfaces under all airport operational weather conditions.

a. The Radar Set shall have an effective range of two nautical miles, under heavy rain conditions (16 mm/hr), and shall be capable of providing a presentation adequate to allow the Control Tower Operator to distinguish between light aircraft and ground vehicles, heavy commercial aircraft, and very heavy commercial aircraft.

b. The Radar Set shall be capable of accommodating either of two types of configurations: (1) a remote antenna tower installation; and (2) a control tower antenna installation.

1. The remote antenna tower installation shall provide for mounting of the radar antenna and radome at the top of an antenna tower of up to one hundred (100) feet in height, with the radar transmitter/receiver electronics located in an equipment room which may be at the base of the antenna tower. The remote antenna tower may be located at a distance of up to six thousand (6000) feet from the control tower which houses the display equipment. The control tower may be as much as three hundred (300) feet in height. The control tower cab at the top of the tower will house the radar operational controls and displays. An equipment room, which may be at the base of the control tower will house the display electronics.

2. The control tower antenna installation shall provide for mounting of the radar antenna and radome on the roof of the control tower cab. The radar transmitter/receiver and display electronics will be located in an equipment room within the control tower structure. The radar operational controls and displays will be located in the control tower cab.

c. In addition to providing the performance to meet the operational needs of the Local and Ground Controllers, the Radar Set developed under this specification shall minimize the radar maintenance problems. It shall provide a highly reliable and an easily maintainable equipment through conservative design, common sense, functional electrical and mechanical modular construction and documentation.

d. It is the intent that the Radar Set developed under this specification will be a prototype of a replacement for the presently FAA commissioned ASDE-2 Radar Set.

3.1.1 Item diagrams. The following diagrams portray typical configurations for the ASDE-3 Radar Set and its internal and external interfaces.

Figure 1 - ASDE-3 Typical Control Tower Antenna Installation

Figure 2 - Typical Background Suppression and Boundary Enhancement Block Diagram

Figure 3 - ASDE-3 Remote Antenna Tower Installation

3.1.2 Interface definition.

3.1.2.1 Internal interfaces. The internal interfaces of the ASDE-3 Radar Set are defined as those interfaces which exist between the various elements of the ASDE-3 Radar Set. These include interfaces between:

a. Dual channel main electronic cabinets located in the control tower equipment room or in a remote structure;

b. Antenna, antenna drive and azimuth data takeoff mounted on top of the control tower or remote structure;

c. One or two independently controlled bright displays located in the control tower cab; and

d. Operational controls located in the control tower cab.

3.1.2.2 External interface. The only direct external interface for the ASDE-3 Radar Set shall be with the prime power at a circuit breaker panel conveniently located with respect to the main electronic cabinets. In some installations, the tower bright display and its control unit

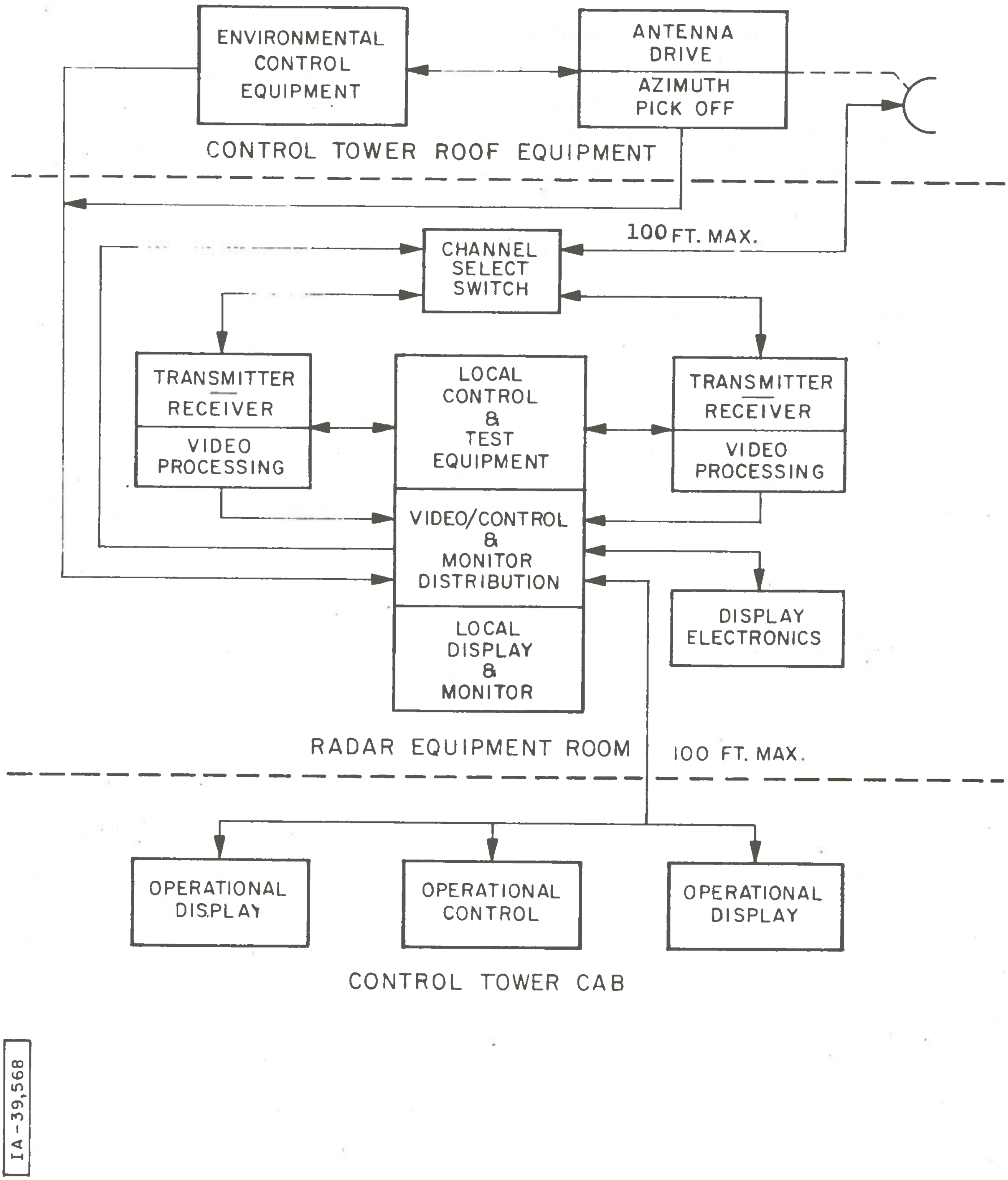


Figure 1 ASDE-3 TYPICAL CONTROL TOWER RADAR INSTALLATION

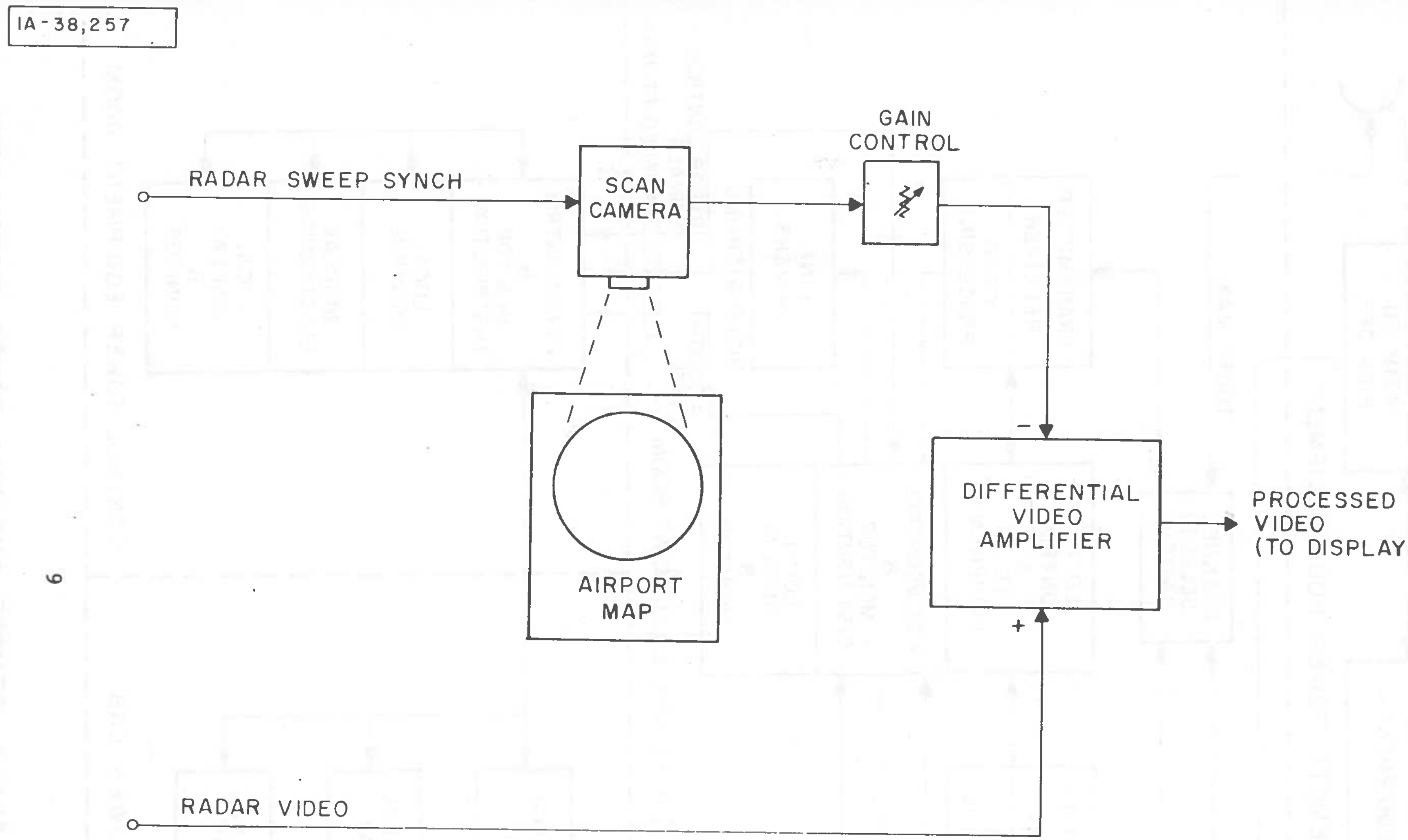


Figure 2 BACKGROUND SUPPRESSOR AND BOUNDARY ENHANCEMENT UNIT

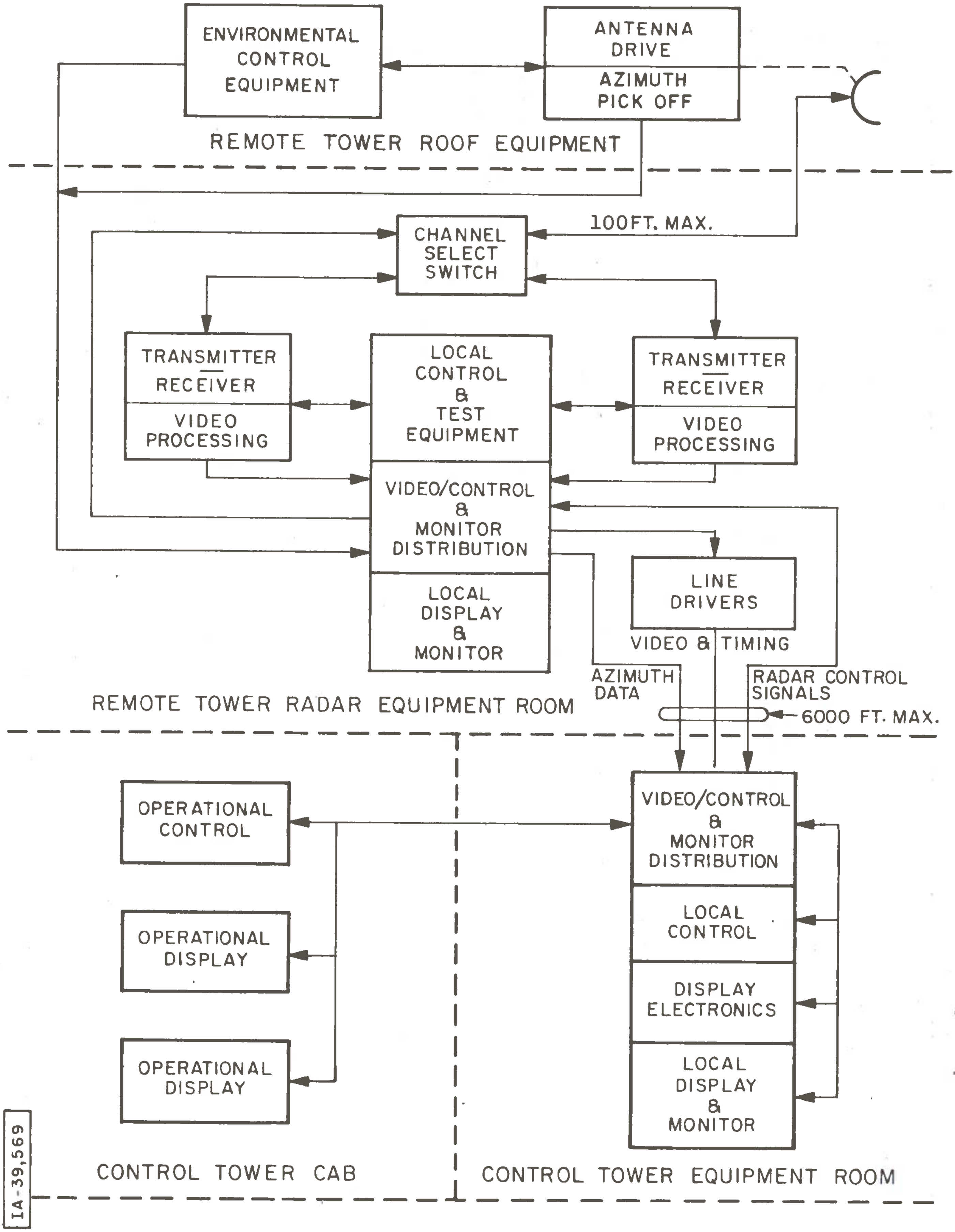


Figure 3 ASDE-3 REMOTE ANTENNA TOWER INSTALLATION

will have a separate local power interface. Interface with the aircraft will be via the operators/controllers. For future expansion to include a digitizer and a computer-driven synthetic bright display, interfaces will be needed between the basic ASDE-3 Radar Set and the digitizing subsystem.

3.1.3 Major component list. The ASDE-3 Radar Set shall consist of the following major components:

a. Antenna, including antenna, antenna feed, drive, and azimuth data takeoff;

b. Radome;

c. RF hardware, including waveguide, waveguide switch, dummy load, duplexer and directional coupler;

d. Transmitter, including RF generator, modulator and high voltage supplies;

e. Receiver;

f. Operational Display;

g. Background Suppression and Boundary Enhancement equipment;

h. Operator Controls;

i. Maintenance Display Monitor;

j. Main Cabinet Controls;

k. Test equipment; and

l. Interconnecting cables.

All equipment other than radome, antenna and drive, and waveguide shall be redundant, with appropriate switching to change from one channel to the other. Deviations from this list that do not compromise the performance requirements specified herein may be permitted subject to approval of the procuring agency.

3.1.4 Government furnished property list. The following types of equipment will be Government furnished. A detailed listing of nomenclature and identification of part/model numbers will be included at a later date.

a. Buildings/structures for housing of cabinets, displays, control panels, etc.;

b. Structures for mounting the antenna and radome;

c. Prime power switching and distribution within the buildings and structures; and

d. Cabling ducts between the main cabinets and remote operational displays and control unit(s).

The Government will furnish all facilities-related services which involve excavation or modification to the airport real estate or structures.

3.1.5 Government loaned property list. This paragraph is not applicable.

3.2 Characteristics.

3.2.1 Performance. The ASDE-3 Radar Set shall be a high resolution radar capable of providing the ground and local controllers with data of sufficient quality to accomplish control of the traffic on the airport surface efficiently in all weather conditions and particularly in rainfall up to and including a rate of 16 mm/hr.

3.2.1.1 Radar operating frequency. Three frequency bands are authorized by international agreement for Airport Surface Detection Equipment, as follows:

14.0 - 14.3	GHz	(Ku band)
24.25 - 25.25	GHz	(K band)
31.8 - 33.4	GHz	(Ka band)

A frequency for radiation of electromagnetic energy by the radar shall be selectable within one (1) and only one of the above bands. Choice of the operating frequency band shall depend on such appropriate design factors as maximum range, resolution, antenna size and weight, performance in heavy rain, etc.

3.2.1.2 Coverage. The ASDE-3 Radar Set shall provide the following coverage:

a. Azimuth: 360°;

b. Elevation:

1. Upper limit: Approximately 0° elevation angle. The exact value of the upper limit of elevation angle coverage depends upon the height of the tower on which the antenna is mounted, which may vary from airport to airport between 40 feet and 300 feet.

2. Lower limit: -22° elevation angle.

c. Range: A three (3) square meter target shall be assumed in satisfying the following range requirements:

1. In clear weather: 3 n.mi. minimum.

2. In rain at a rate of 16 mm/hr.: 2 n.mi. minimum.

3. In other weather conditions such as snow, fog, light rain, etc.: 3 n.mi. minimum.

These range requirements shall be met considering such contributing factors as signal-to-clutter ratio, frequency, transmitted power, receiver noise figure, beamwidths and beamshapes, polarization, pulse width, and other factors which have significant effect.

3.2.1.3 Update rate. The ASDE-3 Radar Set shall obtain a fresh sample of data on each target in its field of view at a rate which is high enough to permit high speed targets (landing aircraft) to present a continuous track on the operational display.

3.2.1.4 Resolution. The ASDE-3 Radar Set shall be capable of providing the ground and local controllers with data of sufficiently high resolution to permit classification of vehicles into 3 sizes and to determine the maximum extent and heading of heavy and very heavy aircraft. A necessary condition for compliance with the resolution requirements set forth herein shall be the clearly defined separation, on the operational display in the control tower cab, of two 3 m^2 wide-angle reflectors separated by 25 feet in radial range and 64 feet in cross range. This condition must be met in the presence of rainfall at the rate of 16 mm/hr. at a range of 10,000 feet in any prescribed direction from the antenna site.

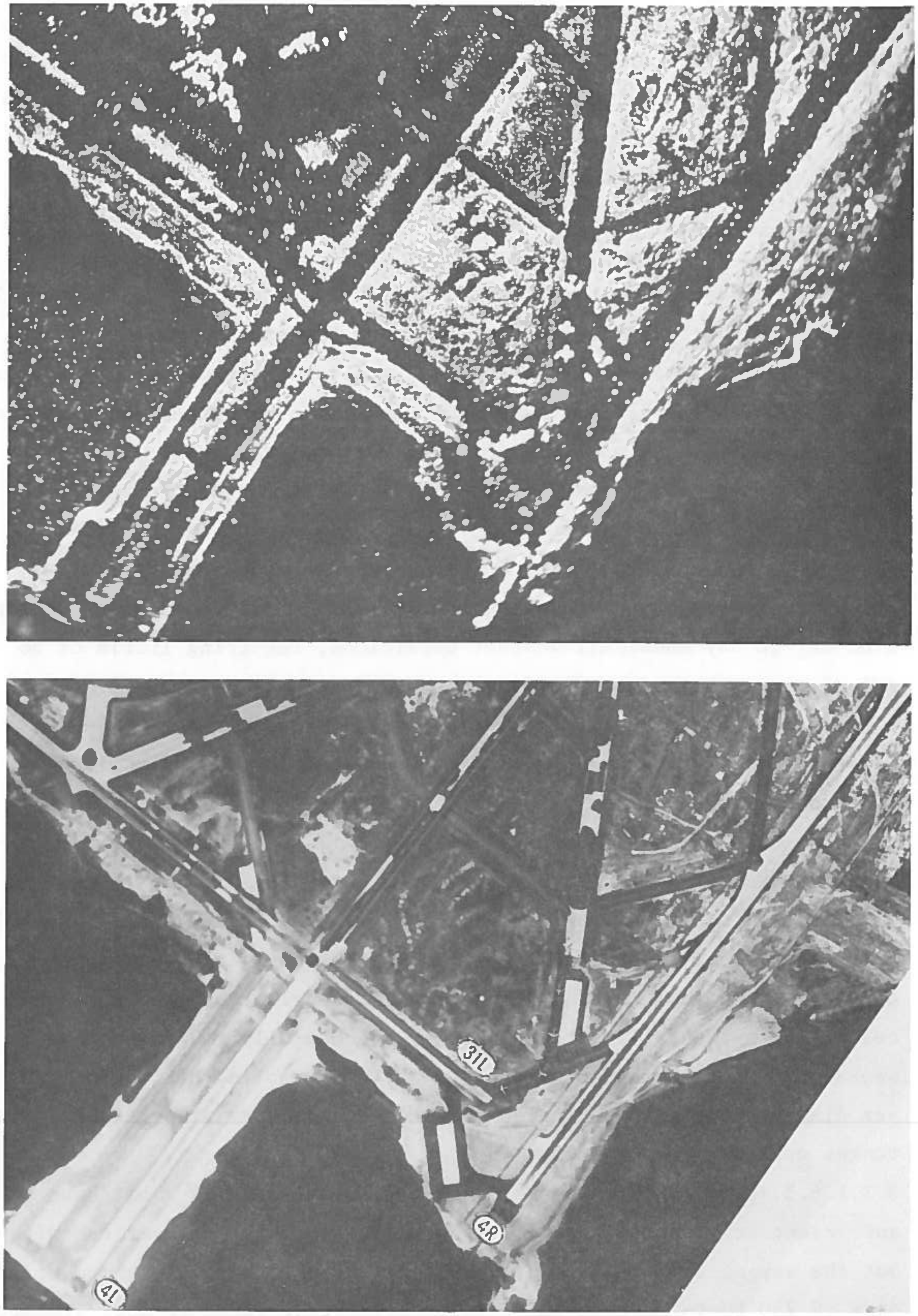
3.2.1.4.1 Vehicle size. All vehicles may be classified into three sizes as follows:

Class	Vehicle Length
Light Aircraft/Service Vehicles	Up to 70 ft.
Heavy Aircraft	70 ft. to 180 ft.
Very Heavy Aircraft	180 ft. and above

3.2.1.4.2 Vehicle shape. The ASDE-3 Radar Set shall provide data of sufficient resolution to enable the ground and local controllers to determine from the operational display the boundaries (shape) and heading of heavy and very heavy aircraft. Figure 4 illustrates the existing ASDE-2 mapping and aircraft shape definition qualities. The critical areas are the runways, the taxiways and the ramp areas. All other areas are background. The resolution of the ASDE-3 Radar Set shall be sufficient to permit the controllers to determine the heading of heavy and very heavy aircraft by observing their shape when they are in a critical area. It shall also be possible to diminish the brightness or eliminate altogether all background areas, and to mark or enhance the boundaries or critical areas.

3.2.1.4.3 Range resolution. The ASDE-3 Radar Set shall have range resolution adequate to meet the requirements of 3.2.1.4, 3.2.1.4.1 and 3.2.1.4.2 above. The ASDE-3 Radar Set shall have sufficient resolution to enable the operators to distinguish on the control tower display two point targets of equal radar cross section when separated by a maximum of 25 feet in range.

3.2.1.4.4 Azimuth resolution. It is desirable to have the azimuth resolution at maximum range equal to the range resolution; however, it is realized that some compromise may be necessary. The ASDE-3 Radar Set shall have sufficient azimuth resolution to enable the operator to distinguish two point targets of equal radar cross section when separated by a maximum of 76 feet in cross range at a range of 2 n.mi.



ASDE-2 PPI AND AERIAL PHOTOGRAPH OF A SECTOR AT JFK AIRPORT

FIGURE 4

3.2.1.5 Accuracy and precision. The 3σ position error of the ASDE-3 Radar Set due to all biases and random causes shall not exceed 10 ft. when locating a point target at a range of 2 n.mi.

3.2.1.6 Display. The operational display of the ASDE-3 Radar Set shall not require the use of a viewing hood. A filter covering the face of the display or built into the face is permissible. In general, the display configuration shall facilitate the rapid transfer of the controller's attention between the view of the airport, as seen through the windows of the control tower cab, and the view as seen on the face of the display. The effectiveness and worth of the radar will be judged based on the ability of the display to transfer the radar's data into a useful presentation. The display, which is the final result of the total radar system performance, must present a clear, accurate and bright presentation that is stable (without deterioration) from day to day under all weather conditions, requiring little or no adjustments, and it must be simple to operate.

3.2.1.6.1 Display size. The operational display for the ASDE-3 Radar Set shall have a minimum diameter such that the controller may discern an overall picture from a distance of 6 to 8 feet and distinguish details from a viewing distance of 1 to 4 feet. A minimum tube diameter of 16 inches is considered suitable.

3.2.1.6.2 Display resolution. The operational display shall have sufficient bandwidth, definition, and resolution to separate clearly anywhere on the usable display surface two single radar resolution cell targets twenty (20) feet apart on the one-mile range scale when operating at maximum display brightness (600 resolved picture points per diameter). This resolution requirement may vary proportionally for ranges greater than one mile.

3.2.1.6.3 Display brightness. The operational display shall have sufficient brightness to permit viewing in the control tower cab without the use of a viewing hood. The display shall have a minimum brightness of 250 foot-lambents and a minimum contrast ratio of 25:1 (related to a 10 foot-lambent unintensified ambient).

3.2.1.6.4 Flicker and jitter. The display shall minimize flicker such that flicker is not discernible to the operator over the range of ambient light. The display jitter shall be less than 0.05% of the display diameter.

3.2.1.6.5 Boundary enhancement and background suppression. The display format shall have the control capability such that background objects can be either painted in, outlined, erased or displayed at the option of the controller.

3.2.1.7 Remote operation - single radar. The ASDE-3 Radar Set shall meet the performance requirements specified herein with the antenna mounted on a 100 ft. tower remoted from the base of a 300 ft. control tower at a distance up to 6000 ft.

3.2.2 Physical characteristics.

3.2.2.1 Weight and size.

a. The total weight of all equipment mounted on the antenna tower or control tower roof shall not exceed 1400 lbs. This includes radome, antenna, pedestal, drive motor, power transfer trains, angle pick-off and all other components required to maintain the radar in operational condition such as de-icers, blowers, etc. The maximum diameter of the radome shall not exceed 18 feet.

b. The electronic equipment such as transmitters, receivers, modulators, power supplies, etc. shall be mounted in standard FAA-E-163b Type III cabinet racks.

3.2.2.2 Dangerous materials and components. The use of dangerous materials and components shall require prior approval of the procuring agency. MIL-STD-454, Requirement 3, shall apply to the use of such materials or components; and, if these items must be used, safety analysis devices and procedures shall be provided to eliminate chance of damage to the Radar Set or injury to personnel.

3.2.2.3 Biomedical support. Radar design shall minimize biomedical problems encountered during acquisition and operation. Consideration shall be given to RF and X-ray radiation hazards, effects on persons with cardiac pacemaker devices, acoustic noise, proper ventilation, and lighting in accordance with MIL-STD-454, Requirement 1, and the FAA-G-2100 series of specifications.

3.2.2.4 Moisture and fungus resistance. Design requirements for fungus inert materials as specified in MIL-STD-454, Requirement 4, shall apply to this specification.

3.2.2.5 Corrosion resistance of metal parts. Design guidelines for the use of dissimilar metals and corrosion resistance as specified in MIL-STD-454, Requirements 15 and 16, shall apply to this specification. All metal hardware exposed to the corrosive effects of the atmosphere, which are not protected by being manufactured of a noncorrosive material, shall be protected by a corrosion resistant metal-clad or metal-plated coating.

3.2.2.6 Storage. Radar elements shall be designed for maximum practicable storage life in an uncontrolled indoor environment without reconditioning before operational use. Provision shall be made such that special handling or maintenance requirements during storage shall be held to an absolute minimum.

3.2.2.7 Radome. The radome shall be of the rigid self-supporting type. The design of the radome and associated equipment shall be such as to allow radar operation under all operating conditions and to withstand all non-operating conditions as specified herein.

3.2.2.8 Distance between transmitter and antenna. The ASDE-3 Radar Set shall accommodate any waveguide run length between the transmitter tube and the antenna feed horn up to a maximum of 100 feet.

3.2.2.9 Redundant channels. All electronic equipment below the antenna waveguide shall be supplied in duplicate, organized into two separate channels. It shall be possible to switch channels in less than one (1) minute when a fault occurs in one of the operational channels. It shall be possible to change the display presentation equipment in the tower cab within ten (10) minutes or less.

3.2.2.10 Primary power. The equipment shall operate on single-phase 60 Hz power at a nominal voltage of 120V/240V or three-phase 60 Hz, four wire, 120V/208V power. Voltage deviation of up to ± 15% or frequency variation of up to $\pm$ 5% shall not affect operation. All performance requirements of the radar shall be met without readjustment when primary power supply voltages and frequency vary, rapidly or slowly, between the limits specified above. Safety devices shall be incorporated to protect all equipment from voltage fluctuations. Momentary loss of primary power (up to five seconds) shall not make it necessary for the radar to go through the full start-up cycle. If power is restored within 5 seconds it shall be possible to switch on the transmitter high voltage within 5 seconds after return of primary power. The total power requirements shall be kept to a reasonable limit.

3.2.2.10.1 Primary power control. Primary power switches and contactors shall be supplied as required for switching the radar main power "on" or "off". Separate primary power switching shall be required for the units located in the control tower cab and at other remote positions.

3.2.2.10.2 Interlock by-pass switches. Each circuit provided with an interlock to open primary power to cabinets and units shall include an externally located momentary contact switch (or push-button) which can be operated to by-pass the interlock without interrupting the operation of the equipment. The switch shall be designed so that it must be held in the by-pass position manually in order to operate, and it shall be recessed so that it cannot be accidentally operated. It shall be mounted on an insulated panel so that the switch and the area immediately around it are not at ground potential. It shall have appropriate "caution" signs. Each switch shall be conveniently located on the exterior of the cabinet or the unit in such a manner that it may be operated with one hand while the other hand is used for opening the access door. This shall not apply to the modulator high voltage power supplies access door or to other applications where the supplier demonstrates to the Government that by-pass switches are unnecessary or undesirable. Any interlocks supplied for RF or X-ray radiation protection shall not be capable of being by-passed.

3.2.2.10.3 Equipment power supplies. All DC power supplies shall have the voltage regulation, ripple suppression and decoupling necessary to ensure that all radar performance requirements are met. All power supplies shall be operated well below their maximum rated power (preferably below 70% of rated power) and shall be extremely reliable and trouble-free and shall be short-circuit protected, so that they do not appreciably degrade the reliability of the Radar Set. Each regulated power supply shall employ its own separate voltage reference and shall not rely upon another power supply for a voltage reference.

3.2.2.10.3.1 Power supply indicators. "Power-on" indicator lamps shall indicate when each power supply is on. Each circuit protected by a fuse or circuit breaker shall have an indicator lamp which shall be illuminated when the fuse or circuit breaker is open. All indicator lamps shall be uniformly located with respect to their associated fuses or circuit breakers, or they may be an integral part of the fuse holder assembly.

3.2.2.10.3.2 Metering of power supplies. Meters and associated switches (for multiple use of meters) for use in measuring all power supply output voltages and currents shall be located on the front panels of the cabinet containing the circuits to be metered, and in remote monitoring positions as appropriate. Each meter function shall be permanently marked on the front panel near the meter to designate the proper reading of each associated switch position. Operation of meter selector switches shall not interfere with proper radar performance. When shunts are used in conjunction with meters to read currents, specially specified meter movements shall be employed with the resistance of the meter movement held to close tolerances to permit at least 3% overall accuracy in true load current measurements. The meter switch shall be provided with an "off" position in which the meter is not connected to any circuit.

3.2.3 Reliability. The reliability requirements for the equipment described by this specification are stated herein in terms of: (1) mean-time-between system relevant failures ($MTBF_{SR}$); and (2) mean-time-between corrective (unscheduled) maintenance (MTBCM).

a. The ASDE-3 Radar Set for either of the configurations described in 3.1b, shall have a specified $MTBF_{SR}$, $\theta 0_{SR}$ as defined herein (see 3.2.3.1), of not less than 2000 hours; and each Set shall have a minimum acceptable $MTBF_{SR}$, $\theta 1_{SR}$ as defined herein, of not less than 1000 hours.

b. Each ASDE-3 Radar Set shall have a specified MTBCM, as defined herein (see 3.2.3.1), of not less than 200 hours; and each Set shall have a minimum acceptable MTBCM of not less than 100 hours.

c. Each of the following major components of the ASDE-3 Radar Set (as defined in 3.1.3) shall have no less than the specified MTBCM (θ_0) and no less than the minimum acceptable MTBCM (θ_1) as listed below:

Major Component	MTBCM θ_0	MTBCM θ_1
1. Antenna	90,000	30,000
2. RF Hardware	30,000	10,000
3. Operational Bright Display	4,000	2,000
4. Operational Control	10,000	5,000
5. Main Cabinet Control	10,000	5,000
6. Interconnecting Cables (contractor furnished)	90,000	30,000

d. The Radome, except for its environmental control assemblies, shall have a specified and a minimum acceptable MTBCM such that no maintenance of any kind other than external washing is required for a period of no less than five (5) years of installed life.

3.2.3.1 Reliability definitions. Reliability terms shall be defined in accordance with MIL-STD-721 and MIL-STD-781 unless specifically modified herein. In the event of conflicts of interpretation, the definitions contained herein shall take precedence.

a. Relevant failure (R): Any malfunction of the Radar Set or its components which degrades performance below those levels specified in 3.0, and which cannot be classified as nonrelevant in accordance with the definition given in c. below. Malfunction of a redundant element shall be classified as an R failure. All system relevant failures, as defined in b. below, shall be counted as R failures. Relevant failures may be attributed, after failure analysis, to any of the following causes: design, manufacturing, or workmanship defects; errors in technical data and documentation, or handbooks; physical or functional deterioration (such as wearout, fatigue, tolerance degradation, drift or other mechanical or electrical instability); or unknown causes. Relevant failures shall be counted in MTBCM determinations.

b. System relevant failure (SR): Similar to relevant failures as defined above, but limited to malfunctions which degrade radar performance below those levels specified in 3.0 of this Specification. Under this definition, a failure in a redundant element of the Radar Set shall be classified as an R failure rather than as an SR failure if either of the following conditions exist: (1) degradation of performance below specified levels does not occur; or, (2) a redundant element has been provided and is switched on-line to replace the failed element within one (1) minute of the actual occurrence of the malfunction and without degradation of performance below specified levels after the replacement has occurred. Only system relevant failures shall be counted in $MTBF_{SR}$ calculations.

c. Nonrelevant failure: A malfunction which, after failure analysis, is proven to the satisfaction of the procuring agency to be caused by any of the following:

1. Damage resulting from improper installation.

2. Damage resulting from accident or mishandling.

3. Failures due to errors by maintenance or operating personnel that are not attributable to errors, lack of clarity,

omissions, or other inadequacies in technical data, instruction manuals, or training.

4. Failure of test instrumentation or equipment that is external to the equipment under test and not provided as on-line performance monitoring equipment or as special test equipment (3.1.3k).

Preventive maintenance (PM) actions performed when scheduled shall not be counted as failures. However, if preventive replacement of an item occurs before the item has accumulated an operating (power on) time, as logged on an elapsed time indicator integral to the item of equipment (see 3.2.4.2f), equivalent to the reciprocal of the failure rate of that item as computed from the RADC Reliability Notebook, AD 821640, then the preventive replacement shall be treated as a system relevant failure. Failures due to factors external to the Radar Set (e.g., extreme weather conditions that exceed design requirements specified herein, failure of the commercial power system) shall be considered nonrelevant. Downtime occurring as a result of an intermittent failure, or as a result of switching to a redundant element, shall be considered nonrelevant, provided that performance is not degraded below specified levels for more than one (1) minute and that no less than sixty (60) minutes of operating time has elapsed between such occurrences, otherwise these degradations shall be counted as SR failures. Nonrelevant failures shall not be included in the determination of $MTBF_{SR}$ or MTBCM.

d. MTBF: The definitions of MTBF, θ_0, and θ_1 contained in paragraph 3.1 of MIL-STD-781 shall apply.

e. MTBCM: The mean of the distribution of time intervals between corrective (unscheduled) maintenance actions undertaken to correct relevant (R) failures. Included in this category are: (1) SR failures; and (2) alignment, recalibration, or other adjustments to the equipment not directly accessible to the operator by use of a knob or switch on the control panel provided in the airport control tower (or other remote operational position). The specified MTBCM is defined as $\theta 0_R$ and the minimum acceptable MTBCM is defined as $\theta 1_R$ in accordance with the definitions for θ_0 and θ_1 contained in paragraph 3.1 of MIL-STD-781.

3.2.3.2 Reliability apportionment. Reliability apportionment shall be accomplished in accordance with MIL-STD-756 and MIL-STD-785, using failure rates estimated from the RADC Reliability Notebook (AD 821640).

a. The reliability requirements $MTBF_{SR}$ and MTBCM for the equipment described by this specification shall be as specified herein. When such requirements are not apportioned herein to at least the unit level, an apportionment to the unit level shall be made such that the specified and minimum acceptable requirements contained herein are met. Such apportioned reliability numerics ($MTBF_{SR}$ and MTBCM) shall then become firm requirements of this specification.

b. In accomplishing this apportionment, all elements of a single channel (including on-line performance monitoring components and channel switching components) shall be treated as serial elements of the reliability apportionment model. Components of a second channel or redundant units that are provided (exclusive of the components necessary for switching them on-line), and that can be put on-line within one (1) minute after the need for changeover has been noted, may be treated as parallel elements to their on-line counterparts in the reliability apportionment model.

c. Appropriate allowances for the reliability of any Government furnished equipment (GFE) (for example, wiring and cabling) shall be included in the apportionment model. The testing program will take note of any failures of GFE which are relevant, and such failures shall be included in the computation of the $MTBF_{SR}$ and MTBCM numerics that are used in determining that the reliability requirements of this specification have been satisfied.

3.2.3.3 Availability.

3.2.3.3.1 Inherent availability. The inherent availability (A_i) of each ASDE-3 Radar Set at each operational site shall be no less than

0.9950. Inherent availability is defined by the expression:

$$A_i = \frac{8760 - (M_{ct} + M_{pt})}{8760}$$

where 8760 is the number of hours per year, M_{ct} and M_{pt} are the total corrective and preventive maintenance downtime (as defined in 3.2.4.1) occurring in a one-year period.

3.2.3.3.2 Operational availability. The operational availability (A_o) of each ASDE-3 Radar Set at each operational site shall be no less than 0.99. Operational availability is defined by the expression:

$$A_o = \frac{8760 - \text{Total Downtime}}{8760}$$

where 8760 is the number of hours per year, and "Total Downtime" is as defined in 3.2.4.1d for a one-year period. The difference between A_i and A_o is due to the allowance in A_o for administrative and supply delays. This requirement therefore serves to guide and constrain the maintenance procedures and staffing as well as the level of spares provisioning at each operational site.

3.2.4 Maintainability. All items of equipment shall be maintainable in accordance with the maintenance concept of repair by replacement, except when repair of an item is more expeditious. Maintenance will entail corrective maintenance at the Lowest Repairable Unit (LRU) level, such as the printed circuit card, and preventive maintenance at all levels.

a. The mean corrective maintenance time ($\overline{M}_{ct}$), for the ASDE-3 Radar Set described by this specification, shall be no more than 0.50 hours, as defined in 3.2.4.1.

b. The maximum corrective maintenance time ($M_{max\ ct}$) at the 90th percentile point of the distribution, for the ASDE-3 Radar Set, shall not exceed one and one-half (1.50) hours, as defined in 3.2.4.1.

c. Each ASDE-3 Radar Set shall require no more than forty (40) hours of preventive (scheduled) maintenance downtime (M_{pt}) per year throughout its useful life, as defined in 3.2.4.1.

d. The ASDE-3 Radar Set shall be designed such that each preventive maintenance (PM) action can be completed in less than two (2) hours. This requirement, which is designated as $M_{max\ pt}$, applies both to those PM actions which necessitate complete shutdown and to those that can be accomplished on-line or while the Set is operating.

e. The ASDE-3 Radar Set shall be designed such that separate PM actions which necessitate shutdown shall not be required to occur with less than a sixteen (16) hour interval of time elapsing between such PM actions.

f. The radome, exclusive of associated environmental control assemblies, shall be designed such that no PM actions are required during the initial five (5) year period of installed life other than a semi-annual cleaning of the exterior surface.

g. The antenna pedestal assembly shall be designed such that PM lubrication of its components, including the antenna drive mechanism, is required no more frequently than once during each ten thousand (10,000) hours of operation; and such that overhaul (including replacement of bearings, gears, or oil seals) is required no more frequently than at the end of each fifty thousand (50,000) hours of operation.

h. The ASDE-3 Radar Set shall be designed such that each required alignment and calibration task on the installed in-place equipment can be accomplished in less than 0.25 hours.

3.2.4.1 Maintainability definitions. Maintainability terms shall be defined in accordance with MIL-STD-721 unless specifically modified herein. In the event of conflicts in interpretation, the definitions contained herein shall have precedence.

a. Corrective maintenance downtime (M_{ct}): All elapsed time from the first recognition that a need for corrective action exists to the time when the Radar Set has been repaired (or the faulty element replaced with an acceptable like element), checked out, and returned to a condition which meets specified requirements. The steps for corrective maintenance downtime shall include all corrective maintenance actions shown in Figure 1 of MIL-STD-721. Corrective maintenance downtime as defined herein shall include: (1) all downtime for corrective maintenance of system relevant (SR) failures, and their associated dependent failures (as defined in paragraph 3.1 of MIL-STD-781); and (2) preventive maintenance (PM) actions which extend beyond the time when corrective maintenance downtime would otherwise have been completed. Corrective maintenance downtime as defined herein shall exclude:

1. Downtime for corrective maintenance on failures other than those classified as SR (see 3.2.3.1b) except for dependent failures associated with SR failures;
2. Downtime for nonrelevant failures;
3. Downtime for scheduled preventive maintenance (PM);
4. Downtime spent waiting for spare parts which the Government has explicitly chosen not to provision at the site;
5. Downtime due to administrative delay.

b. Mean corrective maintenance time ($\overline{M}_{ct}$): The total corrective maintenance time required for repair of each relevant (R) failure and associated dependent failure divided by the total number of such failures that have occurred within a specified period. The steps for corrective maintenance time for each occurrence shall include all corrective maintenance actions shown in Figure 1 of MIL-STD-721. Malfunctions that involve only alignment or recalibration, and do not require repair/replacement of components, shall not be included in the determination of $\overline{M}_{ct}$.

c. Preventive maintenance downtime (M_{pt}): All elapsed time from shutdown of equipment until operation at specified performance levels is resumed. PM actions shall include those shown in Figure 1 of MIL-STD-721, plus adjustment-calibration, checkout, and cleanup times associated with each PM task. PM actions undertaken during the period of corrective maintenance downtime shall not be counted as PM downtime. PM actions on equipment that is off-line, or on-line when such PM actions do not either degrade performance or cause or extend radar downtime, shall not be considered to be either PM or corrective maintenance (CM) downtime, except for preventive replacement actions as defined in 3.2.3.1c.

d. Total downtime: All elapsed CM and PM downtime (M_{ct} + M_{pt}) plus time for supply and administrative delays.

e. Uptime: The total accumulated time during which ASDE-3 Radar Set operations meet or exceed specified performance requirements.

3.2.4.2 Maintainability design. The ASDE-3 Radar Set shall be designed and constructed to facilitate replacement of failed components and adjustment of out-of-tolerance conditions. The design shall be such that all failures (including all alignment/calibration actions) can be remedied at the operational site by FAA radar technicians. The following additional requirements and constraints shall apply:

a. A means shall be provided for indicating major component condition to at least the unit level, and for detecting and isolating failures. This means may be in the form of meters or other visual indicators on the front panel of the equipment. Self test of the Set or its components during operation with status indication should be considered.

b. Means shall be provided for isolating equipment malfunctions to the lowest replaceable or adjustable element, referred to herein as a lowest replaceable unit (LRU). This means may be by detection of abnormalities using a calibration signal (end to end, unit or function), test equipment, or other maintenance procedures. The LRU is defined as the smallest functional component which can be removed from the equipment and reconnected without cutting or soldering any connections.

c. Modular construction shall be used wherever suitable. LRU's shall be modular, pluggable items capable of being quickly removed and securely reconnected. Rack mounted electronic equipment shall be functionally grouped and mounted in tiltable pull-out drawers with connectors that mate with the rack assembly cabling.

d. Test points for all critical measurements shall be provided in accordance with MIL-STD-454, Requirement 32, and shall be accessible without disassembly of racks, connectors, or mounting hardware.

e. All equipment which requires operator control shall be capable of manual operation from the front, or from a remote operator's control.

f. Elapsed time indicators shall be provided, to record the time during which both standby power and operating voltages are applied, for each unit, for all major assemblies that are independently operable (e.g., power supplies), and for each limited life component that requires periodic maintenance, adjustment, or preventive replacement.

g. Alignment or adjustment of equipment upon replacement of an LRU shall be minimized. All elements requiring maintenance, adjustment, or inspection shall be provided with access panels with quick disconnect features, mounted in tiltable pull-out drawers, or be provided with similar means of rapid access.

h. Failure location shall be aided by clear labeling of components, parts and functions within the equipment that can be rapidly related to the equipment instruction book.

i. Accessibility for maintenance and alignment/adjustment actions shall be provided in accordance with MIL-STD-454, Requirement 36. The use of accessible junction boxes is encouraged.

3.2.5 Environmental conditions. The equipment described by this specification shall be designed to meet the environmental conditions at any airport in the continental United States excluding Alaska.

3.2.5.1 Climatic environment. The Radar Set shall meet the climatic environmental conditions as specified below:

a. Ambient temperatures

1. Operating: (a) Indoor equipment (10°C to 30°C)
(b) Outdoor equipment (-40°C to 55°C)

2. Non-operating: (a) Indoor equipment (-40°C to 55°C)
(b) Outdoor equipment (-40°C to 55°C)

3. Storage and shipping: (-60°C to 75°C)

b. Relative humidity

1. Operating: Up to 95% at 30°C including condensation due to temperature change.

2. Non-operating: Up to 100% including condensation due to temperature change.

c. Barometric pressure

1. Operating: From sea level to 10,000 feet.

2. Non-operating: From sea level to 50,000 feet.

d. Salt atmosphere protection

1. Outdoor: (a) Steel - Hot dip galvanize or paint.
(b) Aluminum - Anodize or alodine and/or paint.

e. Sand and dust: Sand .18 to .30 mm diameter and dust .0001 to .01 mm diameter at 35 knots.

f. Rain: The ASDE-3 Radar Set shall withstand rain at a rate of six inches per hour for 10 minutes, and a total of 12 inches per 24 hours, without permanent damage.

g. Wind:

1. Operating: In winds up to 60 knots (90 knot gusts possible) with no degradation of performance.

2. Non-operating: In winds up to 120 knots.

h. Ice conditions:

1. Non-operating: Up to two inches of clear ice on outdoor equipment. This equipment must survive the effects of simultaneous ice loading and wind loading of 60 knots. (The specific gravity of ice can be assumed to be 0.85.)

2. Operating: The equipment shall operate to specification during icing conditions. (Provision shall be made to limit build up of ice on the radome.)

i. Snow conditions: The equipment shall operate to specification under conditions of 36 inches of snow fall in 48 hours. (Provision shall be made to limit the build up of snow on the radome.)

j. Thermal: Sun thermal loading of 250 BTU/hr./sq. ft. in combination with other environmental factors.

k. Lightning protection: All structures shall be suitably protected and grounded. Lightning rods, grounding wires and straps shall be sized to take repeated strikes without failure.

l. Aircraft obstruction lighting and marking: Warning lights and markings shall be provided on the antenna (if exposed) or the radome in accordance with FAA AC 70/7460-1.

3.2.6 Transportability. The equipment described by this specification shall be transportable by rail, air, ship, and highway carrier. Individual components for shipment, except for the radome, shall be limited to a packaged size of no more than 30 feet in length by 8 feet square.

3.3 Design and construction. The requirements of FAA-G-2100/1 shall apply to the equipment described by this specification except for the following:

a. Materials, processes, and parts: In addition to the requirements of FAA-G-2100/1, the following specification requirements shall apply:

1. Electron tubes: FAA-G-2100/2;
2. Semi-conductor devices: FAA-G-2100/3;
3. Printed wiring techniques: FAA-G-2100/4;
4. Microelectronic devices: FAA-G-2100/5;
5. Racks and cabinets: FAA-E-163b Type III;
6. Spare parts peculiar: FAA-G-1375.

b. Service conditions: The requirements of 3.2.5 shall take precedence over paragraph 1-3.2.23 of FAA-G-2100/1.

c. Interchangeability: The requirements of 3.3.5 shall apply in addition to the requirements of paragraph 1-3.14.3 of FAA-G-2100/1.

d. Human performance/human engineering: The requirements of 3.3.7 shall apply in addition to paragraph 1-3.4.1.3 of FAA-G-2100/1.

3.3.1 Materials, processes, and parts. See 3.3.

3.3.2 Electromagnetic radiation. The Radar Set shall be designed and produced in accordance with the requirements of MIL-STD-461 for Class A equipment.

3.3.3 Nameplates and product markings. See 3.3.

3.3.4 Workmanship. See 3.3.

3.3.5 Interchangeability. MIL-STD-454, Requirement 7, shall apply. In addition, the Radar Set shall be constructed in a manner providing a maximum degree of standardization of circuits and card assemblies. Circuit and card design shall be such that all repair by replacement can be readily accomplished without the aid of special tools or test equipment.

3.3.6 Safety. See 3.3.

3.3.7 Human performance/human engineering. MIL-STD-454, Requirement 62, shall apply.

3.4 Documentation. All engineering drawings submitted by the contractor shall meet the requirements of FAA-STD-002. Instruction books shall be provided in accordance with the requirements of specification FAA-D-638. Specifications shall be in accordance with MIL-STD-490.

3.5 Logistics. Depot level type maintenance of all major assemblies associated with the equipment shall be accomplished at the manufacturer's facility. The contractor shall provide adequate spare parts and sub-assemblies/assemblies as required to assure specified performance levels of each Radar Set for one year's operation on a 24-hour per day, seven days per week, basis after its acceptance by the procuring agency. Bench stock levels shall be maintained at each operational site in sufficient variety and quantity to realize the specified maintainability requirements (see 3.2.4). Support and test equipment shall also be provided at each operational site, as appropriate to realize the specified maintainability.

3.5.1 Maintenance. The Radar Set shall be designed such that all maintenance and repair activities shall be performed at the site level with the exception of assemblies, cards, and units that require unique techniques. These will be removed from the equipment at the site, like serviceable replacement elements will be installed, and the failed elements will be repaired and tested at the contractor's plant and returned to site spares stock.

3.5.1.1 Failure detection and isolation. Failures shall be detected and isolated by a combination of a built-in performance monitoring capability and periodic checkout by use of special and/or supplementary test equipment. These techniques, in conjunction with operator observations, shall permit recognition that a fault exists or is imminent, and shall permit isolation of the fault to the point at which repair or replacement can effectively be achieved at the operational site. The design shall incorporate features such as meters, go/no-go indicators, self-test circuitry, and test points to facilitate troubleshooting and fault isolation to the subassembly or part level, as appropriate.

3.5.1.2 Maintenance and repair cycles. Radar equipment shall require a minimum of maintenance and overhaul including scheduled organizational maintenance such as inspection, alignment, adjustment, and cleaning (see 3.2.4). These activities shall be capable of being performed with minimum interference to operations. The design shall provide to the greatest extent possible for preventive maintenance to be performed off-line on redundant items, during periods of reduced operational activity, or during periods when the operational use of the Radar Set is not essential.

3.5.1.3 Levels of repair. The level of repair will normally be replacement of the lowest easily replaceable subassembly (LRU). This shall normally be the printed circuit card or component. Repair of LRU's (if feasible) will be accomplished off-line at the site or at the depot.

3.5.1.4 Special tools and test equipment. There shall be a minimum of test equipment and special tools required. The equipment layout shall provide adequate space to permit the use of tools. When particular tools, gauges, measuring instruments, and other material are required, they shall be located with the unit or assembly where used, and a convenient means for tool mounting shall be included. The design and development of new test equipment to support the Radar Set shall be restricted to those areas where newly developed prime equipment is required to fulfill the mission requirements, or where the configuration lends itself to new or more expeditious maintenance techniques. Where such special facilities are necessary, the requirements of FAA-G-2100/1, paragraphs 1-3.16.23 and 1-3.18 shall apply.

3.5.2 Facilities and facility equipment. Logistic support of GFE facilities and facility equipment at each operational site will be the responsibility of the Government.

3.6 Personnel and training.

3.6.1 Personnel. The Radar Set shall be capable of being maintained by Radar Technicians, GS-9, under the supervision of a Radar Technician, GS-11.

3.6.2 Training. The contractor shall administer and conduct all training at the test site and elsewhere. The FAA will develop an in-house capability with contractor support, so as ultimately to provide all training on a continuing basis.

3.7 Major component characteristics. This Section presents the performance requirements for the main ASDE-3 Radar Set components.

3.7.1 Antenna. The maximum dimensions of the Antenna shall be such as to permit operation inside of a radome with a maximum diameter of eighteen (18) feet and with a maximum diameter of fourteen (14) feet at the interface with the surface on which it is mounted. The maximum weight shall be 1400 pounds, including radome and its associated environmental control equipment. The antenna shall operate over one of the three frequency bands specified in 3.2.1.1.

3.7.1.1 Electrical characteristics.

3.7.1.1.1 Antenna gain. The maximum gain of the antenna shall be that required to yield a 17 dB signal-to-noise (not clutter) ratio on a steady 3 square meter target in a 16 mm/hour rainfall at a distance of 2 nautical miles. Also, the signal-to-noise ratio shall be at least 13 dB per pulse on a steady 3 square meter target in clear weather at a range of 3 nautical miles.

3.7.1.1.2 Radiation patterns.

a. Azimuth pattern: The beamwidth (3 dB points) of the relative one-way power patterns in the principal azimuth plane, taken through the peak of the elevation pattern, shall be such as to meet the requirements of 3.2.1.4.4. The beamwidth between 10 dB one-way points shall be no greater than twice the 3 dB beamwidth with no unwanted sidelobes appearing between the mainlobe and the 10 dB point (no shoulders).

b. Elevation pattern: The antenna elevation pattern shall have that shape that produces at least 13 dB signal-to-noise plus clutter ratio for those ranges that lie between a minimum of 400 feet to a maximum of 2 nautical miles on a steady target of 3 square meters radar cross section with a rate of rainfall of up to and including 16 mm/hour.

c. Azimuth sidelobes: The azimuthal sidelobes shall be at least 23 dB down in the principal elevation plane within 10° of the principal lobe. The sidelobes shall be 32 dB down at angles above 10° from the main lobe.

d. Back radiation: The back radiation shall be at least 33 dB down from the peak of the main beam.

3.7.1.1.3 Antenna bandwidth. The antenna shall be capable of meeting all performance requirements over a band of ± 250 MHz around the selected frequency. It shall be possible to select any frequency within the design frequency band.

3.7.1.1.4 Standing wave ratio. The VSWR for the overall RF transmission waveguide from (but not including) the duplexer through the antenna feed shall not exceed 1.40 throughout the selected frequency band, with the polarizing device and the radome in place. However, no individual component shall have a VSWR in excess of 1.15.

3.7.1.1.5 Polarization. The antenna shall operate with circular polarization.

3.7.1.1.6 Integrated cancellation ratio. The integrated cancellation ratio (ICR) for the selected frequency band at all ranges between 400 feet and 2 nautical miles shall be at least 20 dB as measured in the principal azimuth and elevation planes. (Maximum ellipticity shall be 1.0 dB.) ICR is defined as follows: ICR is the one-way power ratio of energy received with circular polarization from an infinite number of parallel thin wire targets randomly located about an antenna to the energy received from an infinite number of spherical targets randomly located about an antenna.

3.7.1.1.7 Antenna Scan Follow Assembly. Antenna scan follow equipment shall be provided to synchronize the display sweep rotation with antenna rotation. The equipment may be either a digital or analog type with the capability of driving a minimum of five (5) displays. Provision shall be made for proper orientation of the display presentation to a geographic reference direction. The scan follow equipment shall have an accuracy no worse than 0.025°.

3.7.1.2 Mechanical characteristics.

3.7.1.2.1 Antenna mounting pedestal. The pedestal shall be constructed to mount directly on top of existing control towers or other structures. Exposed portions of the pedestal shall be weather-resistant and dust tight. All supported components shall be easily accessible for servicing without requiring major disassembly of any other assemblies/subassemblies. The pedestal assembly shall support and rotate the antenna assembly under the service conditions specified in such a manner that the total cumulative effect of vibrations on the RF characteristics shall not prevent the Radar Set from meeting all performance requirements specified herein. Provision shall be made for easy access to check oil level or other lubrication, and to oil/lubrication fill and drain plugs. The rotating portion of the antenna assembly shall have a boresight indicator or etched mark to indicate the direction of the point of maximum radiation intensity. A 360° angular scale (with 0.5° indications) shall be provided on the fixed pedestal base and shall be capable of adjustment to a reference direction. The design and construction of the antenna pedestal shall be such that noise and vibration transmitted to the control tower cab are kept to a minimum.

3.7.1.2.2 Antenna drive mechanism. The antenna drive mechanism shall consist of a drive motor and a power transfer train which shall rotate the antenna continuously in a clockwise direction through 360° in the horizontal plane at the required speed. The speed of the antenna shall not vary from the selected value by more than ± 10% for wind velocities up to 35 knots over the range of line voltage. The drive motor shall be protected against damage by a resettable overload switch. The antenna shall come to a stop within 20 seconds after power is removed and shall remain in position under the above conditions. If the drive mechanism will not hold the antenna in a fixed position when the motor has ceased rotating, an electrically operated brake shall be provided for this purpose. The brake shall be released automatically by applying power to start the rotation of the antenna, and also it shall be capable of manual release by a mechanical brake latch. Antenna starting torque or angular acceleration shall not cause damage to the antenna tower or control tower. This implies the use of starting devices with heavy or high speed antennas.

3.7.1.2.2.1 Antenna drive safety switch. A safety switch shall be provided on the antenna support structure such that the entrance door to the antenna pedestal cannot be opened without first shutting off both the power to the antenna drive motor and the RF power. Deliberate action shall be required to bypass the safety switch, and it shall be fail-safe and not subject to accidental operation. A safety lock and key shall be provided so that the switch can be locked in the open position. A green light near the switch shall indicate when the switch is open.

3.7.1.2.2.2 Noise and vibration. If the antenna is mounted on the roof of the control tower cab, the noise level inside the cab with the antenna rotating shall be increased by no more than 3 dB over the noise level with the antenna stationary. The ambient noise level within the cab can be assumed to be 50 dB (0 dB = 10^{-10} microwatts/sq. cm). No vibration shall be discernible in the cab when the antenna rotates.

3.7.1.2.3 Antenna elevation adjustment. It shall be possible to tilt the beam so that its maximum power point can be set at any angle between -4° and +3° in elevation with respect to the horizontal. A suitably calibrated scale providing for angular readings in increments of 0.1° shall be provided to indicate beam elevation boresight. Spacing between 0.1° increment marks shall be 1/25 inch or greater.

3.7.1.2.4 Ease of maintenance and repair. The antenna assembly and waveguide shall be constructed so as to be easy to disassemble for maintenance and repair at the top of the antenna support structure, using tools which are either supplied with the equipment or easy and inexpensive to obtain. The design of the antenna assembly shall be such that routine maintenance, including all lubrication and cleaning can be performed by one technician. Complete instructions and illustrations covering disassembly and servicing of the antenna assembly shall be included in the instruction books for the Set. In addition, a lubrication chart constructed of metal shall be placed in plain view on the antenna assembly giving all lubrication data necessary for proper servicing of the antenna assembly.

3.7.2 Radome. The radome shall serve to protect either the antenna assembly or the antenna assembly plus pedestal assembly under all specified environmental conditions. Characteristics given in 3.2.2.7, shall also apply.

3.7.2.1 Material. Either a foam type or a metal space frame radome will be acceptable. This does not preclude other rigid types (fiberglass, resins, etc.) so long as they meet the requirements set forth herein. The design of the radome shall be such as to meet the requirements of 3.7.2.2 and shall permit specified radar performance under the specified rain conditions, with particular emphasis on the effects of run-off of heavy rain (sheeting).

3.7.2.2 Effect upon radar performance. The one-way transmission loss, when dry, shall not exceed 0.75 dB. When wet in rainfall at a rate of 16 mm/hour, this loss shall not exceed 1.0 dB. The peak boresight shift shall not exceed 0.05°, when either wet or dry, throughout all the combinations of azimuth position and elevation tilt. The antenna sidelobes shall not be increased by more than 1.0 dB with the radome in place. The axial ratio of the circular polarized energy leaving the antenna and passing through the radome shall not exceed 1.2 dB from 0 degrees elevation to -5 degrees, nor 3.0 dB from -5 degrees elevation to -25 degrees in elevation.

3.7.2.3 Climatic conditions. The radome shall maintain its physical and electrical integrity (as specified above) under the climatic conditions specified in 3.2.5 at any location in the continental United States, except Alaska.

3.7.2.4 Entrance and safety devices. An entrance door shall be provided in the floor which shall be at least 20 inches square and at least 12 inches from the side wall of the radome to permit entrance into the radome shelter. Provision shall be made in the design of the radome for the safety of personnel against falling and/or injury when above the antenna support structure or inside the radome shelter. An automatic control device, which shall be mechanically connected to the entrance door, shall be provided to directly disconnect the power to the antenna drive motor and RF power when the door is opened (see 3.7.1.2.2.2).

3.7.2.5 Weather protection afforded by radome. The radome shall have provision, either by heating or by other acceptable means, to prevent ice from forming on it, or snow from building up. Temperature and humidity sensors shall be provided to detect icing or snow conditions and to turn on de-icing equipment.

3.7.3 RF hardware. Losses contributed by RF hardware components shall be as specified herein or shall otherwise be apportioned such that the coverage requirements contained in 3.2.1.2 are met. The maximum length of the waveguide run between the transmitter and antenna shall be as specified in 3.2.2.8. The RF hardware shall operate over one of the three frequency bands specified in 3.2.1.1.

3.7.3.1 Power handling capacity. The power handling capacity of the rotary joint, circular polarizer, feed, waveguide switch, dummy load and interconnecting waveguide sections shall be such as to withstand a 3 dB increase in transmitted power above that necessary to meet the requirements of this specification at 0.0010 duty cycle. In addition, a momentary short circuit shall not cause permanent damage.

3.7.3.2 VSWR. The VSWR of the RF hardware components shall be as specified in 3.7.1.1.4.

3.7.3.3 RF hardware component characteristics. The following RF hardware components shall be provided as a minimum, with characteristics as specified in the following subparagraphs: RF energy conductors (waveguide and coaxial cable), waveguide switch, waveguide circulator, directional coupler, and dummy load(s). The RF components shall be fabricated in a manner which will allow pressurizing to a minimum of one (1) atmosphere from the transmitter output to the antenna feed horn; and they shall be designed to withstand twice the maximum required output power at 0.0010 duty cycle with a maximum VSWR of 1.35 at normal atmospheric pressure.

3.7.3.3.1 RF conductors. Waveguide shall be used throughout the RF circuits except where coaxial cable may be required in the local oscillator and mixer circuits. The waveguide shall be properly plated in order to minimize losses. All waveguide shall have an outside protective coating to provide resistance to corrosion.

3.7.3.3.2 Waveguide switch. A remote controlled waveguide switching capability shall be provided which shall permit either transmitting channel to be in the operating mode while the other channel is either in standby status or operating into an RF dummy load. Electrical and mechanical overload protection shall be provided for the waveguide switch. Interlocks shall be incorporated to permit application of high voltage only when the dummy load or antenna is connected to the output of the transmitter with the waveguide switch accurately aligned in either of two positions. Positive positioning of the waveguide switch shall be incorporated. The heat dissipation in the RF dummy load shall not heat the waveguide switch or other components so as to cause mechanical binding or deterioration. The waveguide switch shall not require lubrication, or periodic adjustments more frequently than twice yearly. The VSWR of the waveguide switch in all operating positions shall not exceed 1.10 over the selected frequency ± 250 MHz. The cross-coupling attenuation (electrical isolation) of the waveguide switch shall be at least 30 dB between the RF channels, and the insertion loss of the waveguide switch shall not exceed 0.15 dB over the selected frequency band.

3.7.3.3.3 Duplexer. The solid state duplexer shall be provided for each transmitter, and it shall have sufficient isolation between the output device and the RF energy reflected from the line mismatches to ensure optimum spectrum and power output, and it shall present substantially constant isolation over the selected frequency band. Recovery time shall be consistent with a minimum radar range of 100 feet.

3.7.3.3.4 Directional coupler. A conveniently located bi-directional coupler shall be included in the RF output waveguide of each channel, and the calibrated coupling loss in dB for the complete frequency band shall be permanently tabulated or shown graphically, either on or adjacent to the coupler, so as to be readily visible during the use of the test equipment. The bi-directional coupler shall have a directivity of 30 dB minimum and a maximum VSWR of 1.10 over the selected frequency ± 250 MHz. Coaxial jacks shall be provided for connection of test equipment.

3.7.3.3.5 RF dummy load(s). RF dummy load(s) shall be capable of operating continuously with the prescribed maximum peak RF power and shall be capable of dissipating 50 watts average power under continuous operation without damage or deterioration. The RF dummy load(s) shall present a load impedance such that the VSWR shall be constant and not exceed 1.20 over the selected frequency ± 250 MHz. There shall be no evidence of frequency modulation of the magnetron output signal caused by the RF dummy load(s).

3.7.4 Transmitter. Dual transmitters shall be provided that can be independently switched either to a standby mode to a dummy load, or to the antenna. The transmitters shall operate within one of the three frequency bands specified in 3.2.1.1. It shall be possible to set the transmitter on any frequency within the selected band, and tuning over the range of ± 250 MHz around the selected frequency shall be provided. There shall be no significant interference between channels which will degrade the performance of the operating channel when one channel is in the standby mode or operating in the dummy load.

3.7.4.1 Peak power. The peak transmitted power shall be such that a 17 dB signal-to-noise ratio (not clutter) is achieved for a 3 square meter point target at a distance of 2 nautical miles in rainfall of 16 mm/hr.

3.7.4.2 Pulse width. The pulse width shall not exceed 40 nanoseconds.

3.7.4.3 Pulse repetition frequency. The PRF shall be consistent with range, power, duty cycle, maximum pulse length, and other relevant parameters specified herein. In particular, at least one pulse shall be transmitted and received on a point target within the 1.5 dB one-way power azimuth beamwidth.

3.7.4.4 Spurious radiations and radiation spectrum. The RF spectrum shall conform to the shape of the transmitted pulse. It shall have deep first and second minima, and the envelope of the side and other lobes shall monotonically decrease from the spectrum center. The spectrum energy away from the center shall be sufficiently low so that three radars can be operated in any one of the frequency bands at the same location without mutual interference. In addition the RF spectrum shall show no perceptible evidence of frequency modulation.

3.7.4.5 Transmitter component characteristics.

3.7.4.5.1 Transmitter tube. The transmitter output tube shall be capable of meeting the requirements of this specification. If a magnetron is used, it shall be removable without the necessity of removing the magnet, if the magnet is not part of the tube. Adequate provisions for shielding and cooling, to ensure proper transmitter and radar operation, shall be incorporated. Fail-safe provisions shall be included to automatically discharge any high voltage storage condensers that might endanger the safety of personnel. Interlocks and cooling devices, shall be provided so that the output tube and associated high power components shall not be damaged by failure of any part of the circuitry or cooling system. The design of the equipment shall be such as to eliminate RF leakage, and to limit X-ray radiation in the immediate area of the output tube, modulator and high voltage rectifier to two millirentgens per hour.

3.7.4.5.2 Transmitter Drive. The peak-to-peak ripple on top of the output pulse shall be kept as low as possible. No short transient spikes on the pulse shall exist. There shall be no notches in the pulse and it shall be shaped to reduce spurious frequency generation. Sufficient driving power shall be provided to drive the transmitter to full output power under all conditions of tube life. The design shall incorporate adequate protection features so that failure of one component does not damage any or all other components associated with it.

3.7.4.5.3 Overload protection circuitry. Overload protection circuitry shall be incorporated into the appropriate portions of the transmitter. Overload circuitry shall have properly designed automatic reset features.

3.7.4.5.4 Safety devices. Adequately insulated grounding rods shall be provided inside all cabinets of the radar, with a grounding strap permanently affixed to good cabinet grounds to enable maintenance personnnel to ground all points which are normally at potentials above 70 volts RMS before performing equipment maintenance. Caution plates shall be mounted in all hazardous areas to remind maintenance personnel to utilize the grounding rods and straps before performing any maintenance on the equipment. RF radiation shielding shall be provided as required so as not to exceed 3 mw/cm^2 average power continuous exposure. No X-radiation shall be detectable when transmitter and high voltage power supply cabinet doors are closed.

3.7.4.5.5 Transmitter monitoring. Test points shall be provided for viewing the voltage and current pulses of the transmitter drive.

3.7.4.5.6 RF energy transmission. The RF energy transmission components shall be pressurized if necessary to prevent voltage breakdown.

3.7.4.5.7 High voltage power supplies. The power supplies shall be capable of delivering at least 15% more average power than the normal operating power required for the type of output tube selected and at the PRF and pulse width used in the transmitter design. The voltage output of each power supply shall be capable of furnishing voltages that are continuously variable over range from 30% less than to a minimum of 15% greater than rated value.

3.7.5 Receiver. Two solid state receivers shall be provided, one for each radar channel. The receivers shall operate over one of the three frequency bands specified in 3.2.1.1. There shall be no significant interference between channels which will degrade the performance of the operating channel when one channel is in the standby mode.

3.7.5.1 Receiver sensitivity and noise figure. The sensitivity and noise figure characteristics of the receiver shall be such as to meet the overall performance requirements of the Radar Set.

3.7.5.2 Overall selectivity. The overall receiver RF selectivity shall be at least 100 dB down for RF deviations of $\pm$ 100 MHz from the operating frequency.

3.7.5.3 Overall gain. The overall gain of the receiver, including intermediate frequency and video stages, shall be sufficient to drive up five (5) displays, and shall be compatible with the future digitizer described in TSC Specification TSC/PTG 0012D.

3.7.5.4 IF bandwidth. The IF bandwidth of the receiver shall be adequate to meet the requirements of 3.2.1.4.3.

3.7.5.5 Video bandwidth. The bandwidth of the entire video portion of the receiver, from the second detector to the input of the display, shall be not less than 50% of the receiver IF bandwidth as measured at the 3 dB points. This requirement shall be met while using up to 300 feet of cable between the main electronic cabinet and the operational display and shall be adequate to meet the requirements of 3.2.1.4.3. In addition, this requirement shall be met when the radar antenna tower is remotely located up to 6000 feet from the base of the control tower housing the display equipment.

3.7.5.6 Receiver circuit characteristics.

3.7.5.6.1 Local oscillator (LO). The LO tuning procedure shall not be complicated or critical in adjustment. Maintenance shall require only one technician and shall not be required more frequently than once every two weeks. The LO shall be provided with an automatic frequency control (AFC) mechanism to maintain a constant IF between the LO and the transmitter RF pulse under any operating conditions. The stability of the AFC circuitry shall be such that no adjustment shall be required except during a monthly PM action. The "lock-in" frequency shall be continuously adjustable with one control over a minimum range of the IF $\pm$ 0.5 MHz. The AFC shall be capable of maintaining the "lock-in" IF within $\pm$ 50 kHz.

3.7.5.6.2 Sensitivity time control (STC). The receiver shall be equipped with selectable, independently adjustable sensitivity time control circuits, which shall vary the receiver gain with time so as to maintain the output signal within the dynamic range of the receiver and prevent saturation and attendant pulse stretching. These circuits shall be used to produce a constant signal output over the sweep range when combined with the antenna vertical pattern. They will be initially adjusted for the tower height maximum and minimum ranges of the particular airport. The receiver shall have available a continuous or multi-position control for STC control by the operator, but controls for adjusting the STC waveform are not required at the operator position. An STC-OFF position shall be provided.

3.7.5.6.3 Additional receiver video processing. Techniques such as FTC (fast time constant) and IAGC (instantaneous automatic gain control) shall be provided to enhance the returns of weak targets and boundaries of key target areas and to discern small targets positioned close to larger targets. These techniques shall operate on radar returns in such a manner that weak signals may be observed instead of being lost due to the action of a video limiter or due to amplifier limiting. Provision shall be made for the operators to disable either or both of these features.

3.7.6 Operational display. The control tower operational requirements differ from airport to airport, resulting in the necessity for flexibility in the operational display design. Provision shall be made to operate up to four (4) displays simultaneously in a control tower cab, and each display shall be provided with independent controls. Two separate operational displays and controls shall be provided to meet the requirement of this specification. The displays shall be console mounted units, but provision shall be made to allow the displays to be hung from the ceiling in such a fashion as to be rotatable $\pm 45°$ from a normal position. The displays shall meet the requirements of 3.2.1.4, 3.2.1.5, and 3.2.1.6 for both local and remote radar tower installations as defined in 3.1b. The operational display and controls shall provide the operators with the capability of using the presentation with complete, partial or no background suppression and boundary enhancement (see 3.7.7).

3.7.6.1 Display concept. The display concept shall meet the operational and functional requirements of this specification. Possible examples of acceptable display concepts are, direct view storage cathode ray tube (CRT) with acceptable optical filter, closed circuit TV (combined PPI-TV camera and TV monitor), scan converter TV monitor, or any other reasonable, feasible, and proven method. Only the final bright display tube and associated circuitry will be located in the tower cab. For approaches other than the direct viewing cathode ray tube, all other auxiliary equipment (such as scan converters, vidicon cameras, etc.) shall be supplied in duplicate and be located in the main electronic cabinets elsewhere in the tower. Rotating deflection coils shall not be permitted.

3.7.6.2 Scales and marks. The following range scales shall be provided as a minimum. They shall be selectable from remote switches or from the operational control panel in the tower cab.

Range Scale
0.5 n.mi.
1.0 n.mi.
2.0 n.mi.
3.0 n.mi.

Maintenance adjustments shall permit adjustment of all ranges ± 20% of the nominal ranges listed above. The following range and azimuth marks shall be provided.

3.7.6.2.1 Variable range strobes. Two separate range strobes, continuously and independently variable from zero range to 3 n.mi. shall be provided. Each strobe shall have a separate range control knob and a separate digital readout. The least significant figure of the digital readout shall be no greater than the length of the range resolution cell. Each strobe shall also be capable of independent intensity control down to the sub-visibility level.

3.7.6.2.2 Fixed azimuth strobes. A set of sixteen (16) radial strobes, equally spaced in azimuth to represent sixteen equally spaced compass points about the radar installation, shall be provided. The azimuthal orientation of the set of radial strobes shall be adjustable as a group by at least 25 degrees. The control for this adjustment shall not be easily accessible to the control tower operators. Provision shall be made such that the intensity of the set of radial strobes can be varied as a group by the operators down to the sub-visibility level.

3.7.6.2.3 Variable azimuth strobes. A set of two (2) azimuth strobes that can be positioned by the operators to any azimuth shall be provided. The spacing between the two azimuth strobes shall be continuously variable from zero to an angle of at least five (5) azimuthal beamwidths of the radar antenna. Each strobe shall have a separate azimuth control knob and digital readout of their respective azimuths with respect to true north; however, the control for one strobe shall vary the azimuths of both strobes together (maintaining their azimuthal separation), and the control for the second strobe shall vary only its azimuthal separation from the first strobe. The digital readouts shall indicate the strobe azimuth to a precision equal to or greater than 1/3 of the radar antenna beamwidth. Provision shall be made such that the intensity of the set of azimuth strobes can be varied as a group by the operators down to the sub-visibility level.

3.7.6.3 Display decentering. It shall be possible to decenter simultaneously the sweep origin of both the video and background suppression/boundary enhancement displays (see 3.7.7) by up to 2.5 n.mi. The sweep length shall be sufficient to cover the entire display surface when maximum decentering is selected. A two-position switch shall provide for selection of either normal centering or decentering. Two continuously variable controls shall position the X and Y location of the origin when the switch is in the decenter position. There shall be no interaction between the centering and decentering circuits and the selection of "center" shall always return the sweep origin to the same center position Decentering shall not affect the registration between the video representation of the airport and any separately generated airport background suppression or boundary enhancement features.

3.7.6.4 Shielding and isolation. There shall be no noticeable flashing or distortion of sweep and signals, such as may be caused by extraneous 60 Hz pick-up on the remoting cables, or inadequate isolation from circuits incorporated in the equipment having high transient voltages and currents, or any other electrostatic or electromagnetic pick-up.

3.7.6.5 Intensity and focus. No noticeable variations in intensity or focus shall result when the range scales are changed. Stability and regulation shall be such that intensity and focus controls shall not require adjustment more frequently than weekly. These controls shall provide uniform focusing over the display surface with the control at 10% of its midway setting. A vernier intensity control providing adjustment to compensate for variations in ambient illumination, shall be provided for use by the operator.

3.7.6.6 X-ray radiation. The maximum permissible X-ray radiation shall be 75 mR per week at a distance of 1 foot in the direction of maximum radiation.

3.7.6.7 Other display features. Additional features which will be favorably considered in evaluating display proposals are:

a. Accessibility of components for maintenance;

b. Absence of audible noise;

c. Circuitry to prevent burning of display surface due to sweep failure or synchro failure; and

d. Other factors that would facilitate maintenance, such as an adequate number of video test points, and that would provide greater operator comfort and efficiency.

3.7.6.8 Display physical construction. The output display assembly shall be housed so that it may be set up adjacent to the operational control panel or hung from the roof just above the window. In the window mounting, the display shall be capable of being rotated for best viewing in the cab. The design of mounting and cable connections shall permit rapid replacement of the output display assembly with a spare unit in case of failure The display cabinet shall include a face plate and fittings suitable for mounting a camera to record the display presentation.

3.7.7 Background suppression and boundary enhancement. The Radar Set shall include provision for presenting boundaries, such as runway and taxiway boundaries, fences, barriers, etc. on the PPI display. Runways are normally 150 feet across and taxiways are normally 75 feet across. This equipment shall have the capability to enhance desired boundaries while leaving the runway areas dark, and to suppress undesired ground clutter echoes. The method employed shall be easily adaptable to the airport's geometry and changes in airport configuration. Two separate remotely operated controls shall be provided for adjusting the enhancement of boundaries and the suppression of undesired ground clutter. The method employed shall be compatible with the requirement to have independently controlled operational displays in the control tower cab.

3.7.8 Operational controls. Operator controls shall be provided in the tower cab to permit the controllers to exercise all control functions suitable for proper operation of the Radar Set and its operational displays.

3.7.8.1 Radar controls. Layout of the control panel shall be subject to Government approval. A representative list of the required should include the following:

Description	Switches or Controls	Indicator Lamps
Radar Main Power	Off-Standby-ON	Standby, ON
Antenna Rotation	ON-OFF	ON
Radar Overheat		DANGER
FTC, STC, IAGC	Receiver Processing Controls as required	
De-icing	ON-OFF	ON
Channel Select	CH.1-CH.2	CH.1 ON, CH.2 ON
Remote-Local Control		Local ON
Indicator Lamp Dim	Control	
Receiver Gain	1-4 positions	
Self Test Status		CH.1 GO, NO-GO CH.2 GO, NO-GO

3.7.8.2 Display controls. The following is a suggested, but not necessarily complete, list of controls required for operation of the operational displays:

Power ON-OFF

OFF-Center X

OFF-Center Y

Center-Decenter

Brightness

Contrast

Video Gain

Range Select: 0.5, 1.0, 2.0, 3.0 n.mi.

3.7.9 Maintenance displays. Displays shall be provided to monitor the performance of the Radar Set in the radar equipment room(s). The design shall be such as to accommodate either of the two type of installations as defined in 3.1b.

a. Remote antenna tower installation: Two maintenance displays shall be provided for this type of installation. One display shall be located with the main radar electronics in the remote tower radar equipment room and shall be switchable between the two transmitter/receiver channels. This display shall also monitor the performance of the radar at the input to the transmission line leading to the control tower radar equipment room. A second maintenance display shall be located in the control tower radar equipment room. This display shall be switchable: (1) to monitor the signal at the output of the remote transmission lines; or (2) to monitor the information being transmitted to the operational displays in the control tower cab.

b. Control tower antenna installation: A single maintenance display shall be provided and located with the main radar electronic in the control tower radar equipment room and shall be switchable: (1) to monitor the signal before background suppression and boundary enhancement, or (2) to monitor the information being transmitted to the operational displays in the control tower cab.

These CRT displays shall have a diameter of at least 12 inches and shall conform to the performance requirement given in 3.2.1.4, 3.2.1.5, 3.2.1.6, and 3.7.6. These displays shall have sufficient brightness to be viewed in a lighted room at normal ambient, and shall be provided with standard controls such as focus, intensity, video gain, etc.

3.7.10 Main cabinet control. Two control panels shall be provided with each ASDE-3 Radar Set, one for each of the dual channels. If possible each panel shall be mounted as an integral part of the main equipment cabinet. A representative list of the required radar controls and indicator lamps is given below, but the total requirement is not restricted to this list. Layout of the control panels is subject to Government approval.

NOMENCLATURE	SWITCHES OR CONTROLS	INDICATOR LAMPS "ON"
Radar Main Power	Off-Standby-ON	Standby, ON
Antenna Rotation	ON-OFF	ON
Radar Overheat		DANGER
FTC	OFF-1-2-3	
STC	OFF/Low/High	
IAGC	ON-OFF	
De-icing	ON-OFF	ON
Channel Select	CH.1-CH.2	CH.1 ON, CH.2 ON
Remote-Local Control	Remote, Local	Local ON, Remote ON
Indicator Lamp Dim	Control	
Receiver Gain	Continuous	
Self Test Status		CH.1 GO, NO-GO CH.2 GO, NO-GO

The Remote-Local switch transfers control of the Set from this panel to the operational control in the tower cab, and vice versa.

3.7.11 Test equipment. A set of built-in test equipment, switchable between channels, shall be provided. The test equipment shall be mounted in a separate cabinet with appropriate front panel switching, indicators, and built-in wiring to key test points in order to permit rapid check out. All signals or signal insertion points required for performance monitoring or calibration and alignment shall be easily connected through appropriate switching or cable connectors to the test equipment or indicators necessary to perform the monitoring or adjustment functions. All test equipment required for performance monitoring or calibration and alignment shall be permanently mounted in the test equipment rack; and no special external adapters, portable meters, reconnecting cables, and the like shall be required for the above-named servicing actions. The contractor shall propose a list of test equipment for inclusion in this specification as an SCN at a later date. The list shall include an "A" scope, digital volt-ohmmeter, a signal generator, test pattern generator, and other items of special test equipment and features, as follows:

3.7.11.1 Adjustable range strobes. The display monitor in the control tower equipment room shall be provided with two adjustable range strobes similar in capability to those specified in 3.7.6.2.1.

3.7.11.2 Adjustable azimuth gate. An adjustable azimuth gate shall be provided which permits selection and display on an "A" scope of one (1) to ten (10) successive sweeps beginning at any azimuth from zero to 360 degrees.

3.7.11.3 Self test. GO, NO-GO indication and NO-GO alarm shall be provided at the operational control in the tower cab and at the main cabinet control, which will alert the operator to change channels when system performance is out of specified tolerance limits.

3.8 Precedence. This specification shall take precedence over any referenced specification or standard. Within this specification the requirements for:

Availability
Range performance in hydrometeors
Resolution
Display quality

shall have equal weight and take precedence over all other requirements.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General. The objectives, policies and procedures for acquisition test and evaluation as delineated in AFR 80-14 and in Section 1-4 of FAA-G-2100/1 shall apply as guidelines of this specification. The objective of this test program is to determine that the ASDE-3 Radar Set meets established requirements and specifications for functional and operational performance. Unless otherwise specified in the contract or SOW, the contractor shall be responsible for the performance of all quality assurance actions. Except as otherwise specified herein, in the contract, or in the SOW, the locations for each of the specific test and evaluation actions shall be recommended in the applicable contractor-prepared test plan/procedures and will be subject to approval by the procuring agency. The procuring agency reserves the right to perform or witness any of the test and evaluation actions. Existing test data obtained from previously qualified components may be used to satisfy quality assurance requirements subject to the prior approval of the procuring agency.

4.1.1 Test plan/procedures. The test plan/procedures for qualification of the equipment shall be subject to approval by the procuring agency prior to the accomplishment of any test or evaluation actions. The following are guidelines for selection of test methods and procedures:

a. General - FAA-G-2100/1.

b. Environmental - MIL-STD-810, MIL-STD-202.

c. Reliability - MIL-STD-781, MIL-STD-756, RADC Reliability Notebook (AD-821640).

d. Maintainability - MIL-STD-471, MIL-HDBK-472.

e. Electromagnetic compatibility - MIL-STD-462.

f. Human engineering - MIL-H-46855.

4.1.2 Special tests and examinations. These test and evaluation actions are accomplished by the contractor's personnel separate from the formal qualification program. They encompass Engineering Test and Evaluation, Preliminary Qualification Testing, and Installation and Checkout. Although conducted separately, the results of any of these special tests and examinations may be required by the procuring agency as prerequisites for the start and/or satisfactory completion of the formal qualification program.

4.1.2.1 Engineering test and evaluation. Tests shall be accomplished by the contractor throughout the design, development, and fabrication phases to verify that the requirements of 3.0 will be met and to isolate problems at the earliest possible point in the development program. They include breadboard testing, modeling, and component level testing for parts selection and qualification. No formal procedures are required for these tests; however, all test data shall be made available for inspection by the procuring agency or its designated representatives upon request. These tests shall be conducted and calculations made to indicate that the selection and application of parts, components and materials have been accomplished with appropriate rating for the service conditions and for the functional performance and operability requirements specified herein. The equipment shall be given all electrical tests as specified in MIL-STD-202 necessary to confirm that all circuits are inherently sound and in compliance with the requirements of this specification. Appropriate test methods of MIL-STD-202 shall be selected to determine component adequacy where necessary.

4.1.2.2 Preliminary qualification tests. These tests shall be completed successfully by the contractor prior to the start of the formal qualification tests (see 4.2), and the completion of the preliminary qualification tests shall require formal recognition by the procuring agency. All test data shall be recorded and made available for inspection by the procuring agency or its designated representatives upon request. At its discretion, the procuring agency may designate any specific parts, components or circuits that it deems to be critical for inclusion in the tests specified herein.

4.1.2.2.1 Safety. Safety engineering provisions in design, application, and operation of the equipment described by this specification shall be verified by inspection. Safety items related to maintenance shall be demonstrated by the contractor. Safety items to be verified by preliminary qualification tests shall include those designs, applications, and operations of the equipment that are identified by the contractor as being necessary to ensure that further testing can be accomplished without hazard to personnel.

4.1.2.3 Installation and checkout. These tests shall be conducted in accordance with approved test procedures under the supervision of Government personnel and procuring agency representatives at the operational test site(s) to verify that proper electrical and mechanical installation has been accomplished prior to equipment turn-on so as to assure the safety of personnel and equipment. In addition, a visual inspection and performance checkout shall be made to verify that no damage to components has occurred during shipment to the site(s) or during installation. Successful completion of installation and checkout tests shall be accomplished as a prerequisite to the start of formal qualification tests at the operational site(s).

4.2 Quality conformance inspections. This section describes those actions required to verify that each of the performance and design requirements specified in 3.0 has been met. All trials conducted in response to the requirements of this section shall be of sufficient frequency, scope, and duration to demonstrate not only that the equipment meets the specified operational and performance requirements with high confidence, but also by what margin the requirements have been met. These actions shall consist of inspections, analyses,

Table I (continued)

:ements :aph No./Title	Evaluation Method* I	A	D	T	Remarks/ Reference
.10 Primary power	X		X	X	4.2.1, 4.2.3.3, 4.2.3.5, 4.2.4.1, 4.2.4.5
Reliability		X		X	4.2.2.2, 4.2.2.3, 4.2.4.1
.2 Reliability apportionment		X		X	4.2.2.2, 4.2.4.1
.3 Inherent availability		X			4.2.2.1, 4.2.2.3, 4.2.2.4
Maintainability		X	X	X	4.2.2.1, 4.2.3.2, 4.2.4.2
.2 Maintainability design	X		X	X	4.2.1, 4.2.3.2, 4.2.3.5, 4.2.4.2
Environmental conditions			X	X	4.2.3.5, 4.2.4.4
Transportability	X		X		4.2.1, 4.2.1.1, 4.2.3.4
Design and construction	X		X	X	4.2.1, 4.2.3.1, 4.2.3.3, 4.2.3.5, 4.2.4.2, 4.2.4.4
Electromagnetic radiation		X	X	X	4.2.2.5, 4.2.3.5, 4.2.4.3
Interchangeability	X		X	X	4.2.1, 4.2.3.2, 4.2.4.2
Human performance/human engineering	X		X	X	4.2.1, 4.2.3.1, 4.2.3.2 4.2.3.5, 4.2.4.2, 4.2.4.5
Documentation	X		X	X	4.2.1, 4.2.3.2, 4.2.3.5, 4.2.4.2
Logistics	X		X		4.2.1, 4.2.3.5
Personnel and training			X		4.2.3.1, 4.2.3.3, 4.2.3.5
l Antenna	X				4.2.1
l.1.1 Antenna gain		X		X	4.2.2.5, 4.2.4.5
l.1.2 Radiation patterns		X		X	4.2.2.5, 4.2.4.5
l.1.3 Antenna bandwidth		X		X	4.2.2.5, 4.2.4.5
l.1.4 VSWR		X		X	4.2.2.5, 4.2.4.5
l.1.5 Polarization	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5

Inspection
Analysis
Demonstration
Test

Table I (continued)

Requirements Paragraph No./Title	Evaluation Method* I	A	D	T	Remarks/ Reference
3.7.1.1.6 ICR		X	X	X	4.2.2.5, 4.2.3.5, 4.2.4.5
3.7.1.1.7 Antenna Scan Follow Assembly	X			X	4.2.1, 4.2.4.5
3.7.1.2 Mechanical characteristics	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.2 Radome	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.3 RF hardware	X		X		4.2.1, 4.2.3.5
3.7.3.1 Power handling capacity				X	4.2.4.5
3.7.3.2 VSWR		X		X	4.2.2.5, 4.2.4.5
3.7.3.3 RF hardware component characteristics	X			X	4.2.1, 4.2.4.5
3.7.3.3.1 RF conductors	X				4.2.1
3.7.3.3.2 Waveguide switch	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.3.3.3 Duplexer	X	X		X	4.2.1, 4.2.2.5, 4.2.4.5
3.7.3.3.4 Directional coupler	X	X		X	4.2.1, 4.2.2.5, 4.2.4.5
3.7.3.3.5 RF dummy load(s)	X	X		X	4.2.1, 4.2.2.5, 4.2.4.5
3.7.4 Transmitter	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.4.1 Peak power		X		X	4.2.2.5, 4.2.4.5
3.7.4.2 Pulse width		X		X	4.2.2.5, 4.2.4.5
3.7.4.3 PRF		X		X	4.2.2.5, 4.2.4.5
3.7.4.4 Spurious radiations and radiation spectrum		X	X	X	4.2.2.5, 4.2.3.5, 4.2.4.3, 4.2.4.5
3.7.4.5.1 Transmitter tube	X			X	4.2.1, 4.2.4.5
3.7.4.5.2 Transmitter drive overload		X		X	4.2.2.5, 4.2.4.5
3.7.4.5.3 protection circuitry	X			X	4.2.1, 4.2.4.5
3.7.4.5.4 Safety devices	X	X		X	4.2.1, 4.2.2.5, 4.2.4.2, 4.2.4.5
3.7.4.5.5 Transmitter monitoring	X			X	4.2.1, 4.2.4.2, 4.2.4.5
3.7.4.5.6 RF energy transmission			X	X	4.2.3.5, 4.2.4.5

*I = Inspection
A - Analysis
D = Demonstration
T = Test

Table I (Concluded)

Requirements Paragraph No./Title	Evaluation Method* I	A	D	T	Remarks/ Reference
3.7.4.5.7 High voltage power supplies		X		X	4.2.2.5, 4.2.4.5
3.7.5 Receiver	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.5.1 Receiver sensitivity and noise figure			X	X	4.2.3.5, 4.2.4.5
3.7.5.2 Overall selectivity		X		X	4.2.2.5, 4.2.4.5
3.7.5.3 Overall gain			X	X	4.2.3.5, 4.2.4.5
3.7.5.4 IF bandwidth		X		X	4.2.2.5, 4.2.4.5
3.7.5.5 Video bandwidth		X		X	4.2.2.5, 4.2.4.5
3.7.5.6 Receiver circuit characteristics	X	X	X	X	4.2.1, 4.2.2.5, 4.2.3.5, 4.2.4.5
3.7.6 Operational display	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.7 Background suppression and boundary enhancement	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.8 Operational controls	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.9 Maintenance displays	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.10 Main cabinet controls	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
3.7.11 Test equipment	X		X	X	4.2.1, 4.2.3.5, 4.2.4.5
5.0 Preparation for delivery	X		X		4.2.1.1, 4.2.3.4

*I = Inspection
A = Analysis
D = Demonstration
T = Test

4.2.2 Analysis. The following requirements of 3.0, and those referenced in Table I, shall be verified by review of analytical data.

4.2.2.1 Maintainability and maintenance cycle. This analysis shall include a review of the maintenance portion (both corrective and preventive) of the contractor documentation, a review of the results of maintainability demonstration and tests (see 4.2.3.2 and 4.2.4.2), and an analysis of the anticipated and demonstrated failure rates of each element of the equipment (as obtained from 4.2.2.2 and 4.2.4.1). Utilizing the above data, the contractor shall verify by analysis that the requirements for $\overline{M}_{ct}$, $M_{max\ ct}$, M_{pt}, and $M_{max\ pt}$, as contained in 3.2.4a through 3.2.4d respectively, have been met; and the contractor shall develop values for $\overline{M}_{ct}$ and M_{pt} from this data to be used in the analysis of system inherent availability, as required in 4.2.2.4. The contractor shall further verify by analysis that the PM cycle requirement contained in 3.2.4e has been met, and that the PM schedule for the Radar Set is adequate and attainable.

4.2.2.2 Reliability prediction. This analysis involves a comprehensive update of the detailed parts failure data, and it shall be performed in the following manner:

a. Parts lists shall be updated to reflect the actual part usage in the equipment submitted for test.

b. All parts stresses (e.g. operating temperature, ratio of operating to rated voltages, etc.) shall either be measured or estimated by analysis. If stresses are estimated by analysis, conservative values shall be used, such as may be obtained by using a value 10% higher (or in the direction that increases the estimated failure rates) than the calculated value.

c. The failure rates for MIL-standard (or JAN) parts shall be determined from the RADC Reliability Notebook (AD 821640), for fixed ground equipment. Choice of quality grade factors used (other than "Lower") must be substantiated. The failure rates for other nonstandard or commercial parts shall be determined by use of the lower quality grade factor contained in AD 821640 for fixed ground equipment. Failure rates for parts not treated in AD 821640 shall be validated by statistical analyses of other data sources, and such estimates must be specifically approved by the procuring agency prior to submission of this reliability prediction.

d. The completed analysis, as performed in accordance with a, b, and c above, shall be compared to the specified $MTBF_{SR}$ and MTBCM requirements as contained in 3.2.3. In the event that the above analysis fails to satisfy the requirements of 3.2.3, the contractor may then submit for consideration by the procuring agency additional historical data to show that the estimated failure rate for an individual part (as obtained in c above) should be reduced. Acceptance of such data, or disapproval of this analysis task, shall be at the discretion of the procuring agency.

4.2.2.3 Reliability ($MTBF_{SR}$). The requirements for $MTBF_{SR}$, as specified in 3.2.3a for the ASDE-3 Radar Set, shall be verified by analysis of the data obtained from the reliability (MTBCM) tests specified in 4.2.4.1.

4.2.2.4 Inherent availability. The requirements of 3.2.3.3.1 shall be satisfied by analytical evaluation of the results of those analyses specified in 4.2.2.1 and 4.2.2.3 when projected over a complete calendar year of operation. The inherent availability (A_i) shall be calculated using the formula:

$$A_i = \frac{8760 - (M_{ct} + M_{pt})}{8760} \qquad (1)$$

where 8760 is the number of hours of operation in a calendar year; M_{pt} is obtained from the analysis required in 4.2.2.1; and M_{ct} is obtained from the formula:

$$M_{ct} = \left[\frac{8760}{MTBF_{SR}}\right] \overline{M}_{ct} \qquad (2)$$

where $MTBF_{SR}$ is obtained from the analysis required in 4.2.2.3; and $\overline{M}_{ct}$ is obtained from the analysis required in 4.2.2.1. The contractor is not required to verify that the requirement for operational availability (A_0) is met (see 3.2.3.3.2).

4.2.2.5 Functional performance analyses. Analyses shall be conducted as referenced in Table I to support the demonstrations and/or tests required in 4.2.3 and 4.2.4, or to verify those requirements that are not feasible to be verified by demonstrations or tests (performance in heavy rain shall be excluded from verification solely by analysis). Specific analyses shall be accomplished to establish the theoretical performance of the radar, including as a minimum the items specified below:

a. Signal-to-noise plus clutter performance for ranges from 400 to 18,000 feet and elevation angles to -22° (tower heights from 40 to 300 feet) under the following weather conditions:

1. Clear weather;
2. Rain at 4, 8 and 16 mm/hr;
3. Snow, wet and dry, with 4 mm/hr melted water content;
4. Fog with 100 foot visibility.

b. Display analyses that identify the required design parameters necessary to achieve the resolution and target size classification requirements specified herein:

1. Display requirements such as spot size, bandwidth, and brightness;

2. Azimuth and range resolution cell requirements to show target shape and heading as specified herein;

3. Relationship between refresh rate, flicker and brightness.

Performance analysis calculations shall be based on a non-fluctuating

$3m^2$ target and a minimum acceptable signal-to-noise plus clutter ratio of 13 dB at all ranges from minimum to the maximum ranges specified. The following 16 mm/hr rain attenuation and backscatter coefficients shall be used in the computations:

Frequency (GHZ)	Two Way Attenuation (dB/n.mi.)	Backscatter Coefficient (Cross-Section Per Unit Volume) $\left(meter^2 / meter^3\right)$
14.0-14.3	4	6.0×10^{-5}
24.25-25.25	12	3.5×10^{-4}
31.8-33.4	18	8.0×10^{-4}

Analyses shall be performed in a complete and rigorous manner consistent with best engineering practices. Details of the analytical procedures and assumptions used shall be included as part of the contractor's proposed test plan/procedures, and shall be subject to prior review and approval by the procuring agency.

4.2.3 Demonstration. The following requirements of 3.0, and those referenced in Table I, shall be verified by demonstration in conjunction with the conduct of tests required in 4.2.4.

4.2.3.1 Human engineering evaluation. All requirements and criteria established for human engineering shall be evaluated in accordance with paragraph 3.2.4 of MIL-H-46855.

4.2.3.2 Maintainability. Maintainability demonstrations for correction of relevant failures (as defined in 3.2.3.1) shall be conducted in accordance with Method 2 of MIL-STD-471, for a consumer's risk (β) of ten (10) percent. These demonstrations shall be performed concurrent with the reliability tests specified in 4.2.4.1 whenever a relevant failure occurs. The results of each demonstration shall be used to verify $\overline{M}_{ct}$ and $M_{max\ ct}$ for the ASDE-3 Radar Set without combination with other maintainability test or demonstration data.

The limitation of time allowed for alignment and calibration (see 3.2.4h) shall also be verified during the reliability tests.

4.2.3.3 Safety. While the maintainability demonstration and test (see 4.2.3.2 and 4.2.4.2) are being conducted, the special procedures, warnings, caution notes, or safety devices that resulted from controlling or eliminating identified hazards shall be demonstrated to be effective.

4.2.3.4 Transportability. This requirement shall be verified by the successful and safe shipment of the equipment from the contractor's plant to the operational test site(s) utilizing the approved packaging designs and materials.

4.2.3.5 Functional performance demonstrations. The various functional performance requirements specified in 3.0, as referenced in Table I, shall be demonstrated on a non-interfering basis during the conduct of the reliability tests specified in 4.2.4.1. In case of conflict, the reliability test procedures shall take precedence. The results of these functional demonstrations shall be combined as appropriate, compared with analytical results (see 4.2.2.5), and further evaluated to verify that specified performance requirements have been met and to establish the degree or level of performance that has been attained.

4.2.4 Tests. The following requirements of 3.0, and those referenced in Table I, shall be verified by formal tests.

4.2.4.1 Reliability. Reliability qualification tests shall be performed concurrent with performance testing to verify that the specified reliability and inherent availability requirements have been met, to determine the achieved MTBCM with respect to the specified and minimum acceptable reliability requirements, and to identify deficiencies and/or marginal performance requiring corrective action. The reliability prediction required in 4.2.2.2 shall be completed to the satisfaction of the procuring agency prior to the start of these tests.

a. Prior to the start of the reliability tests each Set shall be assembled in-plant and subjected to a minimum period of 80 hours burn-in at full operational power. During this period (and at a frequency of no less than once each twenty-hour period) the primary input voltage and frequency shall be varied randomly between maximum and minimum specified values, and critical voltage and waveform measurements shall be recorded. At the end of the burn-in period these same measurements shall be repeated, a complete visual inspection and a performance test shall be performed, and all data shall be recorded and analyzed. A final performance test on each Set shall be given under standard ambient conditions specified in paragraph 3.1 of MIL-STD-810; and all modes of operation shall be demonstrated and all outputs shall be checked. Approval to proceed with the reliability tests shall be subject to: (1) attainment of full compliance with specification requirements at the end of the burn-in period; and (2) maintenance within tolerance ranges (as specified in the approved tests procedures) of those variations noted during the burn-in period.

b. The reliability tests shall be conducted in accordance with Test Plan XVIII of MIL-STD-781, Test Level A-1, to verify that the requirements for MTBCM (as specified in 3.2.3b, c, and d) have been met. Accept-reject criteria shall be in accordance with Test Plan XVIII of MIL-STD-781 with the following additional stipulations:

1. Any relevant failure of the antenna or of the radome in any Set shall constitute cause for rejection.

2. The percentage of the total number of relevant failures that shall be permitted in any Unit/Assembly/Subassembly of the Set shall be in proportion to the failure rate contribution of that Unit/Assembly/Subassembly to the total failure rate specified for the Set, such as may be allocated in accordance with the requirements of 3.2.3.2. Any deviation from such distribution of failure rates that exceeds 10% of the allocated distribution shall constitute cause for rejection.

c. It is anticipated that two complete ASDE-3 Radar Sets will be used for these reliability tests. Tests will be conducted both in-plant and at operational test sites to be designated by the procuring agency. The total required test time (1880 hours) shall be divided approximately equally between the in-plant and operational test site locations, subject to the recommendations of the contractor in the test plan/procedures and subject to the approval of the procuring agency. The intent is to exercise the Sets under the normal ambient conditions found in the operational environment. During the entire test period the Sets under test shall be cycled such that operating voltages are switched off, for a period of at least thirty (30) minutes, at least twice during each twenty-four hour period.

d. Tests shall be conducted to verify that all items of equipment that are designated as redundant (or parallel) elements, in accordance with the definitions contained in 3.2.3.2b, can be placed on-line within the specified switch-over time and without affecting or degrading the performance of the Set, such that specified performance is met immediately after the switch-over has occurred and within the specified switch-over time limit.

e. During the entire test period all failures or malfunctions occurring shall be remedied and their times-to-repair shall be recorded and documented. All failures and malfunctions shall be thoroughly analyzed to determine (with the approval of the Government's Test Director) those which should be classified as relevant failures. Time-to-repair for each failure or malfunction shall be used to satisfy the maintainability demonstration requirements of 4.2.3.2. All corrective actions identified for each failure occurrence shall be documented. In addition, during the test period the approved PM schedule shall be demonstrated and the time for performance of each scheduled PM task shall be documented; provided, however, that the PM tasks shall be performed under strict control and observation by Government representatives so as not to invalidate the reliability test results.

f. In the event that a reject decision is approached during these tests, the contractor, subject to approval of the Government's Test Director, may elect to stop the test, incorporate corrective action into all Sets under test, and rerun or continue the reliability test (the choice shall be subject to the approval of the Government's Test Director). In the event a reject decision is reached, the test shall be immediately stopped, corrective action incorporated into all Sets under test, and the test rerun until an accept decision has been reached.

4.2.4.2 Maintainability tests.

a. Maintainability tests shall be performed in-plant by simulation of faults, or induced failures, in accordance with MIL-STD-471. Task selection shall be accomplished in accordance with Appendix A of MIL-STD-471. Results of this test shall meet the maintainability requirements of 3.2.4 without combination with other maintainability test or demonstration data. The procuring agency reserves the right to require reruns of this test, if corrective action modifications are thought to be of such significance as to compromise the previously obtained maintainability test data.

b. Tests shall be performed in-plant on each of the scheduled preventive maintenance tasks in accordance with MIL-STD-471, Method 6. The objective of these tests is to verify that the requirements for M_{pt} and $M_{max\ pt}$ have been met, and that the proposed preventive maintenance schedule is attainable.

4.2.4.3 Electromagnetic radiation. Tests shall be conducted in-plant in accordance with MIL-STD-462. The following test methods shall be used as a minimum:

a. Methods CE03 and CE04 for power and control emission tests;

b. Method RE03 for spurious and harmonic emissions; and

c. Methods CS08 and RS03 for susceptibility.

In addition, Set susceptibility to electromagnetic interference in the operational environment shall be tested at the operational test site(s).

4.2.4.4 Environmental. Tests shall be conducted in-plant in accordance with MIL-STD-810 to verify that the requirements of 3.2.5 have been met. The selection of test methods to be used and the sequence of testing shall be included in the contractor's proposed test plan/procedures, and shall be subject to the review and approval of the procuring agency.

4.2.4.5 Functional parameter tests. Tests shall be conducted by the contractor in-plant to demonstrate the design adequacy and the design margin of each unit of equipment in accordance with the approved test plan/procedures. Tests on individual units which can be accomplished independently from the balance of the ASDE-3 Radar Set shall be performed prior to integration. A logical build-up of tests, covering the full range of operating modes and parameters, shall be planned in all cases. This test requirement shall not be considered to have been satisfied until all performance requirements of this specification are shown to be met with corrective action modifications installed. Final system test will be accomplished as a demonstration concurrent with performance of reliability tests (see 4.2.3.5 and 4.2.4.1).

5.0 PREPARATION FOR DELIVERY

The designs of packaging, preservation and packing applicable to shipment of material shall be governed by the ultimate destination, mode(s) of transportation to be utilized, length and type of storage, and induced or environmental conditions. Reusable plastic containers with identification, shall be required for small components.

6.0 NOTES

This Section is not applicable.

10.0 APPENDICES

10.1 Special instructions. The following special instructions shall apply in interpreting the contents of this specification:

a. Equipment item levels, both those which are referenced herein and those which remain to be defined, shall be treated and/or assigned in the following hierarchical order;

Set
Unit
Assembly
Subassembly
Part

b. Wherever requirements are stated herein to "include" a group of items, parameters or other considerations, "include" shall be construed to mean "include but not be limited to."

c. Wherever reference is made herein to a section or paragraph number in a document, that reference shall also apply to all subordinate paragraphs and subparagraphs of the named section or paragraph.

10.2 System considerations. The ASDE-3 Radar Set is the basic building block for a radar-based System being developed as part of the Airport Surface Traffic Control program, a program to define, develop and field test techniques, equipment and systems to facilitate the movement of ground traffic through the airport ramps, taxiway and runway network. The ASDE-3 effort may be followed by the development of a mating subsystem that converts the ASDE-3 Radar target data into digital format for computer processing and presents the information in a synthetic display. This subsystem will allow the implementation of multiple radar configurations (up to three radars) at airports that require more than one radar for complete coverage. In addition, this subsystem will be mechanized to allow manual and

and automatic insertion of aircraft identification information to provide ID tags on the synthetic display.

10.2.1 Operational concepts. The mission of the ASDE-3 Radar Set is to assist the traffic controllers in the control tower cab in observing, controlling and directing aircraft and vehicular traffic on the runways and taxiways within the airport. The two functions which require airport ground surveillance are ground control and local air control.

a. The local controllers are responsible for inbound aircraft until they have cleared the active runways, and for outbound aircraft from the taxiway holding line at the entrance to the runway until they have taken off.

b. The ground controllers are responsible for vehicles and aircraft on the taxiways between the runways and the ramp or apron areas at the gates. The ASDE-3 displays in the control tower cab will be observed by both the local controller(s) and the ground controller(s). Communication between them will be by voice and by use of flight strips. All controllers communicate with the aircraft by radio. The display unit may be mounted at the controller's console or be hung from the roof above the window, so that it can be viewed by all tower cab personnel. In large airports where the traffic is dense, two or more displays may be required. Their use may be apportioned on a sector basis, or on an arrival/departure basis. With future expansion to a multiple radar System, the displays will present a combined picture of all the radar outputs. With further expansion to include a digitizer and digital data processing, the bright display will be synthetic and will present additional data such as flight number, heading, speed, etc. Course, optimum ground route, and potentially hazardous situations will be calculated by the computer and may be presented to the ground controller.

The System will interface with the

ARTS System via the computer. Communications with aircraft will be via radio in either the analog or digital system configurations. In multiple radar configurations, the display will present a combined picture of all the radars.